

Inflation Targeting for China?

An Exploration of the Inflation Generating Process

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Preface

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Abstract

Due to the widely observed effectiveness, Inflation Targeting Framework (ITF) has gained increasing popularity among monetary policy makers worldwide. This thesis seeks to explore the applicability of this policy framework in China based on a thorough study of the inflation generating process. When tested against annual data from China, the classic Svensson (1997) model does not work well. This might be caused by the assumed absence of supply-side factors. An alternative model based on Chand and Singh (2006) is then introduced, allowing influences from the supply side, thus losing this assumption. According to the subsequent test, Chinese inflation is primarily a demand-driven process. This makes it potentially possible to adopt demand management strategies like Inflation Targeting. But when it comes to actual implementation, China still has a long way to go. And among the necessary preparations, reforms in the financial sector are truly essential.

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Chapter 1 Introduction

In this thesis, the issue of concern is how to manage inflation in China.

China is now the world's sixth largest economy, growing at an average rate of 9% or so. However, a high degree of fluctuation can be easily detected when looking at the path of inflation. Since 1978, the beginning of China's Opening-up Policy, there has been four episodes of inflation already, 1980, 1985, 1988 and 1994-1995, followed by an episode of deflation for about 3 years after the Asian Financial Crisis in 1997. In recent years, however, inflation rate seems to be on the rise again. With the importance of inflation stability in mind, we are naturally led to the issue of inflation management in China. How to stabilize inflation rate over time? What lessons can we learn from the experience of other countries? Should government policy be used actively? If so, is monetary policy sufficient in dealing with the task? These are questions that lead this research. And the primary purpose is to find a practical resolution for the inflation management in China.

One of the phenomena worth mentioning is the increasing popularity of Inflation Targeting Framework (ITF) among monetary policy makers around the world. It has been spread over to more than 20 countries in a short history of 15 years. And the combination of flexible exchange rate and inflation targeting has become so popular that it is now claimed to be the 'new paradigm for monetary policy'. Among the increasing number of studies conducted to test its effectiveness, most have arrived at a positive conclusion. (see Mishkin and Schmidt-Hebbel (2001), Berg (2005), Petursson (2004), Vega (2005)). It is indicated that on average, inflation has been reduced in countries that adopt an inflation target, and this reduction, according to Petursson (2004), is even more pronounced in emerging-markets. Inflation targeting also helps in reducing the volatility of inflation in these countries, with no significant cost in growth or employment. The apparent success of Inflation Targeting Framework leads us to the following question: is ITF also a possible way out for China to achieve long term stability of inflation?

The existing literature on the adoption of ITF in developing, transition and emerging economies do not seem to have a consensus. Besides the positive empirical evidence mentioned above, there are some other concerns. Masson, Savastano and Sharma (1997) argued that the absence of other nominal anchors and the presence of a quantitative framework linking policy instruments to inflation are key prerequisites for a country adopting

inflation targeting, but they are usually absent among developing countries. Mishkin (2003) goes one step further to have five elements listed, presenting their fundamental institutional differences from advanced economies that are crucial to sound theoretical models and policy advice. These are:

1. *Weak fiscal institutions (...fiscal dominance).*
2. *Weak financial institutions including government prudential regulation and supervision (...financial dominance).*
3. *Low credibility of monetary institutions.*
4. *Liability dollarization.*
5. *Vulnerability to sudden stops of capital inflows (external dominance).*

As one of the few relevant studies of Inflation Targeting in China, Tsang (2002) argued that the reforming and constantly changing institutional setup, the uncontrollable price components, the regional diversities and the multiple objectives in the formulation of development strategy can all cause serious problems for the adoption of ITF.

However, we should not reject the future prospect of a framework simply because we are not yet ready. A sound judgment should be made according to whether it is capable in bringing better outcomes to the economy in case of adoption. It is in this spirit that IMF has recommended Inflation Targeting Framework for developing countries, despite the apparent absence of prerequisites in most cases. It is argued that the commitment to ITF will serve as an incentive device to promote necessary reforms in these countries (IMF 2005). It is also in this spirit that Chand and Singh (2006) studies the applicability of ITF in India by testing the postulated economic structure of standard ITF models. They find an alternative inflation generating process that better characterizes the present situation in India, based on which they suggest coordinating efforts of monetary, fiscal institutions and supply oriented measures. They believe it delivers better inflation outcomes than ITF's reliance on interest rate adjustments does.

A similar approach is to be adopted in our study of ITF's applicability in China. Chapter 2 first gives an overview of the theory of Inflation Targeting, presenting a standard theoretical formulation and subsequently testing it with Chinese macroeconomic data. Chapter 3 introduces an alternative model based on Chand and Singh (2006), allowing more flexibility in the policy analysis by combining both demand- and supply-side factors. It is considered a more appropriate approach for the discussion of inflation management in relatively less-developed countries like China. The model is then tested in Chapter 4, and policy implications are given accordingly.

Chapter 2 Inflation Targeting Theory

The primary purpose of this chapter is to understand inflation targeting from a theoretical point of view. A simple review is given in Section 2.1 for some important discoveries in macroeconomics that have paved the way for inflation targeting theory. Based on the rationale provided by these discoveries, a standard model of inflation targeting is then presented in Section 2.2 based on Svensson (1997) with strict inflation targeting in a closed economy. Section 2.3 concludes the chapter by summarizing the main assumptions.

2.1 The Rationale for Inflation Targeting

Inflation Targeting Framework (ITF) is a monetary policy framework first adopted by New Zealand in 1990. According to Bernanke et al. (1995):

Inflation targeting is a framework for monetary policy characterized by the public announcement of official quantitative targets (or target ranges) for the inflation rate over one or more time horizons, and by explicit acknowledgment that low, stable inflation is monetary policy's primary long-run goal. Among other important features of inflation targeting are vigorous efforts to communicate with the public about the plans and objectives of the monetary authorities, and, in many cases, mechanisms that strengthen the central bank's accountability for attaining those objectives.

Generally speaking, the rationale behind ITF follows several trends in macroeconomic theory. First, price stability is believed to be the only macroeconomic variable which can be affected by monetary policy in the long run. Second, given the unsatisfactory result of monetary targeting and the difficulty of maintaining fixed exchange rates, the rate of inflation naturally stands out to be the new candidate for nominal anchor. Third, after decades of hot debates over “Rules vs. Discretion”, ITF seems to reconcile the conflict with its feature of constraint discretion, not only holding in its hand the flexibility of discretion but also the credibility of policy rules. We look into each of them hereafter.

2.1.1 The Role of Monetary Policy

Whether or not monetary policy can affect real economy is an issue constantly under debate in the history of macroeconomics. Keynesian¹, the orthodoxy in the post-war period, believes in the existence of a long-term trade-off between inflation and unemployment. They argued that a government is capable of steeling the economy away from extreme situations and smoothing the business cycle, thus building up grounds for active policy interventions. But in the early 1970s, when the active policies carried out by major economies failed to alleviate their problems, the loyalty towards Keynesian theory finally reached its end. Since then on comes the “Neoclassical-Keynesian Synthesis”, which is the common ground between the rivaling Monetarists and New Keynesian economists.

In the late 1960s, the Monetarist School pioneered by Friedman and Phelps put the Keynesian Phillips Curve under attack. They differentiate between long term and short term analyses, arguing that the trade-off only exists in short run due to stickiness of price adjustments, while in the long run, when prices adjust freely, monetary policy would have no effect on real economy and unemployment would eventually return to its natural level. In the long run, inflation is considered only a monetary phenomenon. Any expansionary attempts of policy makers, as would be suggested by their Keynesian beliefs, would have no decreasing effects on the natural rate of unemployment, but they do leave the long run inflation rate permanently increased. Therefore, monetary economists believe in rules, by which they can anchor public expectations, and always fight against government discretion.

New Keynesian economists are different from monetarists who mainly focus on equilibrium conditions. They believe in the persistence of disequilibrium and are therefore more active in policy analyses. But the two schools do share the same analytical framework, namely, the short-term vs. long-term dichotomy, the long-term ineffectiveness of monetary policy, as well as the short-term trade-off between inflation and unemployment due to the presence of sticky prices. Actually, this analytical framework has already become the consensus of modern macroeconomics and is also one of the basic beliefs of the inflation targeting countries. It leads these monetary authorities to set price stability as their primary long-term goal. The goal is assigned higher importance than other goals such as high real growth, low unemployment, financial stability and balance of payment. Monetary policy is only capable of supporting the other goals, not influencing them directly.

¹ Note that the Keynesian here does not refer to the original thoughts from Keynes himself.

2.1.2 The Quest for an Effective Nominal Anchor

According to Leiderman and Svensson (1995), inflation targets have generally been introduced either after disappointing experience with monetary targeting, or after being forced off fixed exchange rates. Therefore, the rationale behind inflation targeting can also be interpreted from a nominal-anchor perspective.

Given the long-term ineffectiveness of monetary policy, the value of money is the only thing for monetary authorities to influence in the long run. Therefore, they should aim at stabilizing money value instead of any other real economic variables.

Under the Gold Standard, every single bill is backed by gold. Government's ability to issue paper currency excessively is therefore strictly restricted, resulting in a fairly stable currency value. The era of gold standard actually corresponds to the most stable period in human history. Under a fiat money arrangement, on the contrary, the value of money is somewhat arbitrarily controlled by the government. Paper money itself has no intrinsic value. The value, instead, depends on its expected purchasing power at the time of transaction in the future. Accordingly, the objective to stabilize currency value can now be translated into the stabilization of expected future purchasing power. And Nowadays, finding an effective nominal anchor to peg public expectations is of crucial importance to monetary authorities around the world.

Bretton Woods is a period of fixed exchange rates, with US dollar as the only currency backed by gold and all the other currencies maintaining fixed exchange rates against it. US dollar is valued at 35 dollar per ounce of gold, which in effect sets the value of this interlinked currency network. After the collapse of Bretton Woods, different efforts have been made in nominal anchor setting with the hope of fixing exchange rates again, among which there are dollarization, currency board and so forth. However, the efforts of fixing exchange rate can leave a country extremely vulnerable to speculative attacks. Just think about 1992-1993 in Europe, 1994 in Mexico, 1997 in Southeast Asia, 1998 in Brazil and Russia, and 2000-2001 in Turkey. The lesson has already been taught with enough crises. It is said that for emerging market economies, the only sustainable choice for their exchange rate arrangement is either a pure float (with absolutely no intervention in the foreign exchange market) or a hard peg (like currency board or dollarization). But neither of them can stand out to be a sure winner. A pure float may lead to unprecedented fluctuation in real economy and naturally stir up negative feelings in our security-seeking minds. A hard peg, however, guards against uncertainty, but inevitably hands in its monetary autonomy to the target currency. Therefore, although some

countries still stick to their status quo while constantly pondering over the alternative, an increasing number of countries have already abandoned fixed exchange rate in favor of the float.

However, we might miss the point if single-mindedly searching for the proper exchange rate setting. The thing is, even if a network of exchange rates has been built up, either fixed or constantly adjusted, a specific anchor is still needed to peg the value of this entire ‘network’ before it can stabilize public expectations. It is this anchor that we are searching for, the thread connecting us with the kite, rather than the way that different parts of the kite get connected. A hard peg, say, dollarization, is simply a free-rider mechanism for the small economies. Just as the European countries adopting a single currency still need monetary policies of European Central Bank to stabilize price level in the long run, dollarization only exports the inflation management task from a small country to the United States, while the United States still have to face the problem up right. Therefore, to fix the exchange rate alone cannot be an effective nominal anchor. The Inflation Targeting approach, by targeting future inflation rate and letting exchange rate purely float, gets hold of “the thread attached to the kite” and is finally capable of affecting public expectations of the currency value. Therefore, it is more likely to be the right candidate for an effective nominal anchor.

2.1.3 The Rules vs. Discretion Debate

One of the essential features of inflation targeting theory is its emphasis on credibility and transparency. That’s mainly the result of the rules-vs.-discretion debate.

Kydland (1977) first pointed out the dynamic inconsistency problem involved in optimal policy analyses. Expectations of future policy are considered to affect people’s current decisions. Therefore, when an optimal policy is carried out and people’s decisions affected, the optimal used-to-be is no longer optimal. Given this, policy formulations under discretion might turn out to have counter-stabilizing effects on the economy. Instead, adopting policy rules can help coordinate between policy objectives and people’s expectations, thus achieving better results. Friedman’s simple rule of maintaining a constant money growth is a classic example. Later, we have McCallum (1988) Rule, proposing a reaction-function rule for the growth rate of money supply with respect to the deviation of nominal output growth from its target; we have Taylor (1993) Rule, proposing an interest rate rule as a function of inflation gap and output gap; and we also have Orphanides (1999) Rule, another interest rate rule as a

reaction function of inflation rate, nominal output and equilibrium interest rate. However, it is rather difficult to judge which one of them has the virtue to stand out.

It was Barro (1983) who raised the credibility issue within the field of monetary policy, questioning central bank's doubtful gesture of pursuing low inflation. Because the Phillips Curve trade-off does exist in the short-run, it is obviously optimal for a discretionary authority to inflate the economy and trade it for lower unemployment and higher income. And when people adapt their beliefs, raising their inflation expectations, the real effect of the monetary expansion will vanish, leaving merely an Inflation Bias, which is unfortunately a permanent increase. Different proposals were made afterwards to solve the inflation bias problem. Rogoff (1985) suggests delegating monetary policy to an independent central banker with a reputation of strong dislike towards inflation. And others suggest signing an inflation contract between the government and the central bank, just like what the Reserve Bank of New Zealand has done, linking the income of the central banker with the outcome of inflation management to provide sufficient disincentives for monetary myopia. The inflation targeting literature, too, is one of the efforts fighting against inflation bias. By publicly committing to a quantitative inflation target and cherishing reputation and credibility, it poses a long term constraint on the central bank's decision problem and at the same time allows discretion in the short run. It is claimed that inflation targeting framework links policy to medium- and long-term horizon without crippling the central bank's ability to respond to short-run developments, and it creates a rough compromise between the discipline and accountability of rigid rules and the flexibility of the discretionary approach (Bernanke 1999).

The combination of inflation targeting and a flexible exchange rate has become the new paradigm for monetary policy. But among the inflation targeting literature, there are different ideas concerning what is the proper type of policy rule it should adopt, instrument rule or targeting rule (Svensson 2002).² But this is clearly beyond the scope of this thesis. We'll not explore this topic any further.

² Instrument rule refers to the practice of committing to the reaction function derived from central bank's optimization problem. Targeting rule refers to the practice of committing to the first order condition itself, rather than the result. Targeting rule is considered more flexible. (see Svensson 2002)

2.2 ITF as Central Bank's Decision Problem

After enough background information, we now turn to the theory of inflation targeting itself. Inflation targeting is a framework for deriving optimal monetary policy under a long term constraint. The most important component is that central bank publicly commits to a specific numerical target and promises to achieve it in the long run. Central bank, a dynamic optimizer, then tries to choose the best future path for its instrument given a postulated dynamic structural model economy, aiming at achieving its policy objectives.

In mathematical terms, a dynamic optimization problem normally consists of an objective function, spelling out the criteria for optimality; control variables, over which we have control and by which we could influence the future path of the system; state variables, describing the status of the system, and the law of motions, describing the dynamic mechanism governing its development. Svensson gives a clear theoretical formulation of the inflation targeting problem (Svensson 1997). And we will use this classic and simple model to explain the fundamentals.

2.2.1 Loss Function

The rationale behind stabilization policy is that fluctuation can do damage to social welfare. Central bank generally cares about social benefit, or, wants to minimize social loss. And the loss function is the objective function in this dynamic optimization problem. Central bank wants to stabilize inflation, and more specifically, it wants to maintain stability over a long period of time.

In Svensson (1997) model, the instantaneous loss function has the following form

$$L(\pi_t) = \frac{1}{2}(\pi_t - \pi^*)^2 \quad 2.1$$

where π^* is the inflation target and π_t is the inflation rate of period t. Svensson (1997) model was then sorted as 'strict inflation targeting', as oppose to 'flexible inflation targeting', where the objective function also includes output stabilizing considerations:

$$L(\pi_t, y_t) = \frac{1}{2}[(\pi_t - \pi^*)^2 + \lambda y_t^2] \quad 2.2$$

Here, y_t is the output gap in period t. λ reflects the weight that is put on real considerations in the decision process. Clearly, the latter is a more general formulation. When $\lambda=0$, flexible inflation targeting will be reduced to exactly the same as strict inflation targeting. But, we'll

stick to the strict version to proceed, because it is enough to reflect the basic decision process involved and it can simplify the calculation a lot.³

Based on the strict version of instantaneous loss function, we have the inter-temporal loss function as follows, where central bank minimizes the expected present value of all future loss from inflation fluctuations:

$$E_t \sum_{\tau=t}^{\infty} \delta^{\tau-t} L(\pi_{\tau}) = \frac{1}{2} E_t \sum_{\tau=t}^{\infty} \delta^{\tau-t} (\pi_{\tau} - \pi^*)^2, \quad 0 < \delta < 1 \quad (\delta \text{ is the discount factor}). \quad 2.3$$

2.2.2 Policy Instrument

The choice of policy instrument is actually the choice of control variable. There used to be a hot debate over this issue. One of the classics would be Poole (1970), where he argues whether to choose monetary stock or interest rate as policy instrument should be determined according to specific institutional parameters of the economy in question, or, the relative disturbances that the economy is facing. However, with financial innovations, money stock seems to be increasingly getting out of control, which obviously ruins its candidacy of policy instrument. Therefore, in Svensson's model, as well as most of the contemporary monetary policy literature, the instrument of monetary policy is set default to be nominal short-term interest rate.

2.2.3 Transmission Mechanism and Economic Structure

Svensson (1997) gives the following transmission mechanism for monetary policy:

$$\pi_{t+1} = \pi_t + \alpha_1 x_t + \varepsilon_{t+1} \quad 2.4$$

$$x_{t+1} = \beta_1 x_t - \beta_2 r_t + \eta_{t+1} \quad 2.5$$

$$r_t \equiv (1 + i_t) / (1 + E_t \pi_{t+1}) - 1 \doteq i_t - E_t \pi_{t+1} \quad 2.6$$

$$(\alpha_1, \beta_1, \beta_2 > 0, \beta_1 < 1)$$

$\varepsilon_{t+1}, \eta_{t+1}$ are shocks to aggregate supply and aggregate demand. Both are assumed to be i.i.d. and cannot be known before period $t+1$. π_t is the inflation rate of period t ; x_t is the output

³ Svensson (1997) models strict inflation targeting under closed economy, which is the most basic model setup. For more complicated models of inflation targeting, one can consult Svensson (2003) and Aghor (2000).

gap; i_t is the nominal interest rate; and r_t is real interest rate. $E_t \pi_{t+1}$ is the expected inflation rate of period $t+1$ based on the information available at time t .

By substituting, we arrive at the following law of motions

$$\pi_{t+2} = (1 + \beta_1)\pi_{t+1} + (\alpha_1\beta_2 - \beta_1)\pi_t - \alpha_1\beta_2 i_t + (\varepsilon_{t+2} - \beta_1\varepsilon_{t+1} + \alpha_1\eta_{t+1}) \quad 2.7$$

In equation 2.4, inflation rate is a function of previous inflation, previous output gap and current supply shocks. In equation 2.5, output gap is determined by previous output gap, previous real interest rate and demand shocks. The model assumes a one-year lag between inflation and output gap, and a one-year lag for interest rate to affect aggregate demand. The fact $\beta_1 < 1$ corresponds to the long run monetary ineffectiveness, because the immediate effects of interest rate adjustments will gradually die out as time passes by. However, the coefficient of lagged inflation rate is 1, meaning that the effect on inflation will be permanent. Therefore, monetary expansion will lead to an inflation bias as suggested by Barro and Gordon (1983).

2.2.4 The Central Bank's Problem

The central bank's problem can be presented as follows:

$$\begin{aligned} \min_{\{i_t\}} E_t \sum_{\tau=t}^{\infty} \delta^{\tau-t} L(\pi_{\tau}) \\ \text{s.t. } \pi_{t+2} &= (1 + \beta_1)\pi_{t+1} + (\alpha_1\beta_2 - \beta_1)\pi_t - \alpha_1\beta_2 i_t + (\varepsilon_{t+2} - \beta_1\varepsilon_{t+1} + \alpha_1\eta_{t+1}), \forall t \\ \text{where } L(\pi_t) &= \frac{1}{2}(\pi_t - \pi^*)^2 \end{aligned}$$

Central bank is trying to solve for an optimal path for its interest rate setting, such that along this path the expected future welfare loss is minimized. From equation 2.7, we find that the interest rate of period t can only affect the inflation rate in two periods, that of period $t+2$. It means that the infinite horizon problem above is actually separable and can be reformulated into the repetition of the following:

$$\begin{aligned} \min_{i_t} E_t \delta^2 L(\pi_{t+2}) + E_t \sum_{\tau=[t,\infty), \tau \neq 2} \delta^{\tau-t} L(\pi_{\tau}) \\ \text{s.t. } \pi_{t+2} &= (1 + \beta_1)\pi_{t+1} + (\alpha_1\beta_2 - \beta_1)\pi_t - \alpha_1\beta_2 i_t + (\varepsilon_{t+2} - \beta_1\varepsilon_{t+1} + \alpha_1\eta_{t+1}) \end{aligned}$$

Note that the latter half of the objective function is irrelevant to current choice, which enables us to ignore it when taking derivatives. The first order condition is therefore

$$\frac{\partial E_t \delta^2 L(\pi_{t+2})}{\partial i_t} = -\delta^2 \alpha_1 \beta_2 (E_t \pi_{t+2} - \pi^*) = 0 \Rightarrow E_t \pi_{t+2} = \pi^* \quad 2.8$$

$$\Rightarrow (1 + \alpha_1 \beta_2) E_t \pi_{t+1} + \alpha_1 \beta_1 x_t - \alpha_1 \beta_2 i_t = \pi^* \quad 2.9$$

$$\text{given } E_t \pi_{t+2} = E_t \pi_{t+1} + \alpha_1 E_t x_{t+1} = (1 + \alpha_1 \beta_2) E_t \pi_{t+1} + \alpha_1 \beta_1 x_t - \alpha_1 \beta_2 i_t \quad 2.10$$

Central bank's optimal choice of period t interest rate is the one that would make the expected inflation rate in period $t+2$ hit the target. And the first order condition is equivalent to equation 2.9, given the expression in 2.10 which is obtained from 2.7. Rearranging 2.9 leads us to the following interest rate rule:

$$i_t = E_t \pi_{t+1} + a_1 (E_t \pi_{t+1} - \pi^*) + a_2 x_t, a_1 = \frac{1}{\alpha_1 \beta_2}, a_2 = \frac{\beta_1}{\beta_2} \quad 2.11$$

It says that interest rate setting should respond to current output gap, the expected inflation next period and its deviation from the long run target. In steady state, when real output equals potential output and inflation rate hits the target ($x=0, \pi=\pi^*$), the welfare loss from inflation fluctuation would be zero, and the real interest rate zero too, because nominal interest rate would be set numerically equal to the inflation target.

The above instrument rule looks familiar, with the apparent similarity to Taylor rule, but the two of them are genuinely different. Taylor rule belongs to the simple-instrument-rule category, where the coefficients of the reaction function are obtained statistically from historical practice, while those of the above rule are derived optimally from a structural model, which digs deeper into the way that economy works. Therefore, the accuracy of the model in use is kind of a crucial element in the formulation of this type of rules. However, no matter how accurate a model could be, it is no more than a theoretical simplification of the complex world. Shocks to the economy occur from time to time, under some circumstances even changing the whole picture. In light of this, Svensson further differentiates targeting rules from optimal instrument rules. With targeting rules, central banks commit themselves directly to the first order condition rather than the result derived from it, which allows necessary adjustments to the model in response to possible structural breaks. Targeting rule also requires transparency, which enables it to incorporate more discretionary flexibility into the decision process without any dampening of its credibility. (Svensson 2003).

2.2.5 Summary of Inflation Targeting Theory

Now, we are ready to summarize the key features of inflation targeting theory:

First, the goal(s) of monetary policy is(are) specified in the objective function. In the context of strict inflation targeting, central bank only cares about the stability of inflation, minimizing the welfare loss induced by its fluctuations around the target in all future periods. Under flexible inflation targeting, central bank also care about fluctuations of real economic variables such as output gap, assigning different weights to multiple objectives in the decision process. Generally speaking, the heavier the weight put on real considerations, the more gradual the adjustment will be to make the inflation back to target in response to a shock.

Second, the first order condition of this optimization problem is to have expected future inflation rate equal to the committed long term target. Expected inflation is the intermediate target of monetary policy in this case, and to realize the committed inflation target is the sole responsibility of central bank under this monetary policy framework.

Third, the economy should be dynamic and policy instrument normally takes some time to cast its influence on the target variable. That is to say, monetary policy makers need to act today in order to influence the economic variable tomorrow. Expectation also takes an important part in this process, which brings about the concerns over time inconsistency in macroeconomic policies and the whole issue of independence, transparency and credibility in central bank's decision process.

Fourth, inflation dynamics is assumed to be demand driven in standard inflation targeting models, where monetary policies are demand shocks that affect inflation permanently and real variables temporarily. However, supply shocks do occur in real world, which are literally beyond the scope of the demand management. A concept of core inflation is therefore introduced, excluding the highly fluctuating cost factors in the price index, as the price index that monetary policy makers should focus on.

Finally, we need to say something about the choice of policy instrument as short term nominal interest rate, which the standard inflation targeting theory always takes for granted. Consider the other traditionally accepted instruments, such as money stock and exchange rate. Due to the widely observed endogeneity of money demand and the vulnerability of fixed exchange rate uncovered by successive financial crises, those instruments are no longer appropriate in the minds of most macroeconomists around the world. However, there might be significant deviation from this assumption when analyzing relatively underdeveloped economies and the countries where interest rates are not yet ready to act as policy instruments.

2.3 Test of Svensson(1997) Model's Specification ⁴

We now set out to test the Svensson (1997) Model, the most classic model of inflation targeting we've presented in the previous section. By testing the model, we mean to test its reduced form, where the endogenous future inflation is expressed only in terms of pre-determined and exogenous variables. From equation 2.4-2.6, we get the following reduced form, where the explanatory variables are output gap, inflation and interest rate.

$$\begin{aligned}\pi_{t+2} &= (1 + \beta_1)\pi_{t+1} + (\alpha_1\beta_2 - \beta_1)\pi_t - \alpha_1\beta_2 i_t + (\varepsilon_{t+2} - \beta_1\varepsilon_{t+1} + \alpha_1\eta_{t+1}) \\ &= (1 + \alpha_1\beta_2)\pi_t + \alpha_1(1 + \beta_1)x_t - \alpha_1\beta_2 i_t + (\varepsilon_{t+2} + \varepsilon_{t+1} + \alpha_1\eta_{t+1})\end{aligned}$$

2.3.1 Data

To test the above reduced form, we need time series data of annual inflation (π_t), annual output gap (GAP) and interest rates (I_len for lending rate and I_dep for deposit rate). It is apparently better to use quarterly data under this context, but the report of quarterly data started unfortunately only in recent years. Conducting the research on a yearly basis is therefore the only option left to have sufficient number of observations involved for the validity of statistical inferences.

Inflation and its lag structure

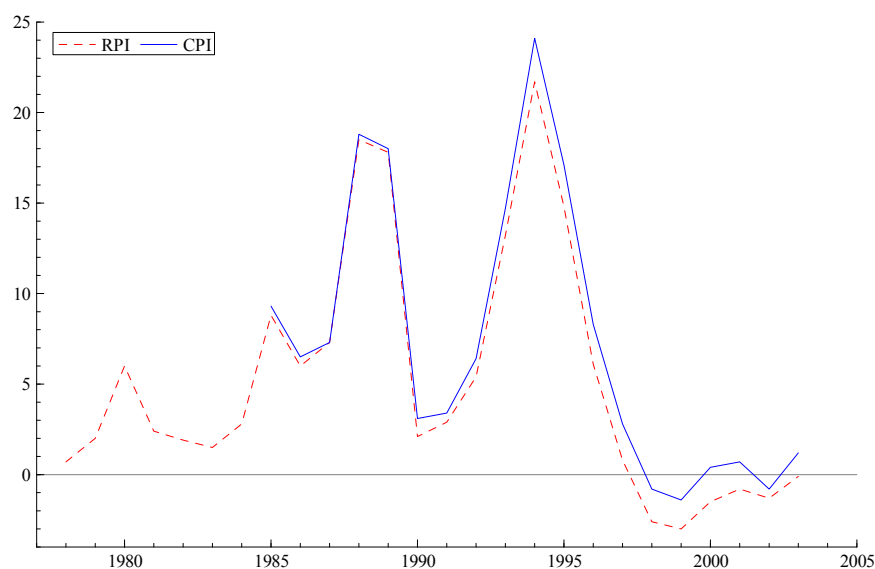
Inflation rate is a flow variable which measures the rate of increase of the general price level over a certain period of time. Price level, on the contrary, is a stock variable measured in a specific point in time. Different ways are employed to reflect different focuses in price measurement. The price indices we can get from National Bureau of Statistics (NBS) in P.R.China include Consumer Price Index (CPI) since 1985, Retail Price Index (RPI) since 1978, Ex-factory Price Indices of Industrial Products (arguably Producer Price Index as in developed countries) since 1985, Purchasing Price Indices of Raw Material, Fuel and Power since 1989 and Investment in Fixed Assets Price Index since 1991. The choice of index to be used in our analysis is more than a simple pickup. It is a tradeoff. On one hand, we need to find a price level that is sufficiently general; on the other hand, we need to be aware of the

⁴ The analysis is conducted using PcGive 10. PcGive is an interactive menu-driven program for econometric modeling and version 10 is the latest version. It uses Give Win for data input and graphical and text output. One can consult Hendry and Doornik (2001) for details of the program.

fact that for developing countries, data quality is always poor, and where there are data, there are always not as many as we need. There's no ready solution to this. All we could probably do is to face the fact and get the best result out of the blue.

Consumer Price Index (CPI), the weighted average price of a specific consumption basket consisting of representative goods and services, is the most common index employed in inflation analysis. Inflation rate can be defined as the rate of growth of CPI. GDP deflator is another popular measure of inflation rate, which is usually calculated by the researcher from the nominal and real GDP that are published. It is probably the most general index, because it takes into account price changes in all newly domestically produced final goods and services in an economy. And it is based on a constantly changing basket, rather than the fixed basket of CPI, and it apparently allows for evolution of consumption pattern over time. But there's one vital fact about GDP deflator that makes it inappropriate for our analysis. It is an implicit index which can only be obtained after a significant lag by calculations based on published data, but the central bank should always act well ahead of time. Since it is only slightly more accurate than CPI inflation, we'd rather make use of the latter.

Figure 2-1 Inflation Measured by Percentage Change of CPI and RPI



(Output from PcGive 10.0)

However, using CPI for China still has a minor problem. Recall that the NBS started its CPI reporting from 1985, we even won't have a sufficient length when using annual data. To solve this problem, we compare CPI inflation with RPI inflation and find that it is appropriate

to assume RPI as a perfect substitute for CPI before 1985. The difference between RPI and CPI is that the latter also includes service sector prices, while the former only reflects the price of retail goods. As shown in Figure 2-1, the two inflation series largely overlap with each other before 1990, suggesting substitutability between them for the corresponding period. Relevant studies also confirm that at the initial periods, after China's adoption of its opening up policy in 1978, service sector is so underdeveloped that RPI and CPI can substitute each other without significant impact on analytical result. (Jiang, 1997) Therefore, we'll construct a CPI inflation series, assuming RPI is a perfect substitute for CPI before 1985, when the CPI is not yet officially published.

The above price level index is reported with constant price on a year-to-year basis. That is to say, each price level index is presented in percentage point with respect to the price level of the previous year. In order to make it comparable, we need to convert it to a base-year index. Based on constant price of 1977, the base year series can be calculated from the original series by cumulative multiplication of all preceding year-to-year indices. Then, we can get the series of inflation by differencing its \log^5 and denote it with P_i .

Table 1 Unit Root Test of Inflation, Output Gap and Interest Rate

Variable (X)	Model	ADF Test	Ho: $\beta_2=1$ H1: $\beta_2 \neq 1$	Conclusion
Pi	$X=\beta_1+\beta_2X(-1)+\beta_3\Delta X(-1)+\varepsilon$	-2.933(-2.991)	Fail to reject	Non-stationary
Dpi		-4.503*(-2.977)	Reject	Stationary
GAP		-4.631*(-2.985)	Reject	Stationary
I(deposit)		-1.293(-2.997)	Fail to reject	Non-stationary
I(lending)		-1.856(-2.997)	Fail to reject	Non-stationary

Note: Values in parentheses are critical values used in corresponding ADF tests at 5% significance level.

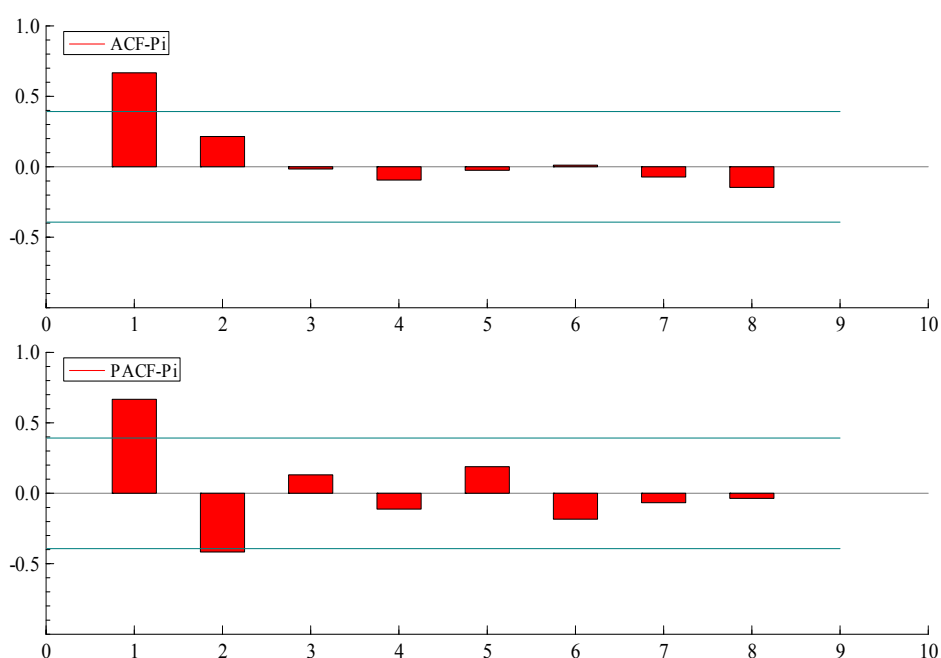
To prevent spurious regression in time series analysis, we need to judge whether the variables are stationary. Table 1 summarizes the results from Augmented Dickey-Fuller (ADF) test for all the relevant variables in our analysis. We can see that the null hypothesis of the existence of a unit root, meaning non-stationary, failed to be rejected for P_i , while it is successfully rejected for its first difference Dpi . One might immediately arrive at a conclusion

⁵ The first difference of its log is approximately the rate of growth.

$$\ln p_t - \ln p_{t-1} = \ln \frac{p_t}{p_{t-1}} = \ln \left(1 + \frac{p_t - p_{t-1}}{p_{t-1}} \right) \approx \frac{p_t - p_{t-1}}{p_{t-1}}$$

that P_i is integrated of order one, or $I(1)$. However, statistically speaking, not reject does not necessarily imply acceptance. Figure 2-2 plots the Autocorrelation Function (ACF) and Partial Autocorrelation Function (PACF) of P_i , where we could find the coefficients of ACF and PACF both dying out pretty quickly. This is the sign of a stationary process. Since it is now well known that the Augmented Dickey-Fuller tests have low power, we fit P_i by an ADL model instead to test its stationarity and lag structure. By choosing the lowest reported information criterion (see Table 2) among different regression models⁶, an ARMA(1,1) specification is finally determined and the regression result is presented in Table 3.

Figure 2-2 Inflation Rate: ACF and PACF



(Output from PcGive 10.0)

⁶ In time series analyses, it is always not easy to decide the proper model specification. Information Criterion is always used to help us choose the best model. Commonly used information criteria include AIC (Akaike Information Criterion), HQ (Hannan-Quinn Criterion) and SC (Schwarz Criterion). However, different criterion might lead to different results. Generally speaking, for cases where sample size is larger than 16, we have

$$\hat{p}(SC) \leq \hat{p}(HQ) \leq \hat{p}(AIC)$$

That is, AIC normally selects the most lags among the three criteria, while SC chooses the fewest.

Table 2 Model Selection Based on Information Criteria

	Log-likelihood	SC	HQ	AIC
AR(1)	43.151047	-3.0687	-3.1376	-3.1655
AR(2)	45.695427	-3.1391	-3.2425	-3.2843
AR(3)	46.170720	-3.0506	-3.1882	-3.2439
MA(1)	46.288481	-3.3100	-3.3789	-3.4068
MA(2)	47.651056	-3.2895	-3.3929	-3.4347
ARMA(1,1)	47.759843	-3.2979	-3.4013	-3.4431
ARMA(2,1)	47.768575	-3.1733	-3.3111	-3.3668
ARMA(2,2)	48.542347	-3.1075	-3.2797	-3.3494

(Output from PcGive 10.0)

The evidence for persistence of inflation is not strong since the coefficient for lagged inflation is only significant at 10 per cent level. However, the moving average term is highly significant, suggesting positive autocorrelation. But the fact that it is less than one suggests the absence of permanent influence from those shocks.

Table 3 Maximum Likelihood Estimation of ARFIMA(1,0,1), Period 1979-2004

Regression function:	$Pi = 0.054^{**} + 0.362 Pi(-1)^{***}$ (0.020) (0.196)
Moving average term:	$u_t = \varepsilon_t + 0.845 \varepsilon_{t-1}^*$ (0.131)

Log-likelihood 47.7598425, Mean(Pi)=0.0576356, var(Pi)=0.0037922, sigma=0.0371447, sigma^2=0.00137973

* significant at 1% level, ** significant at 5% level, *** significant at 10% level

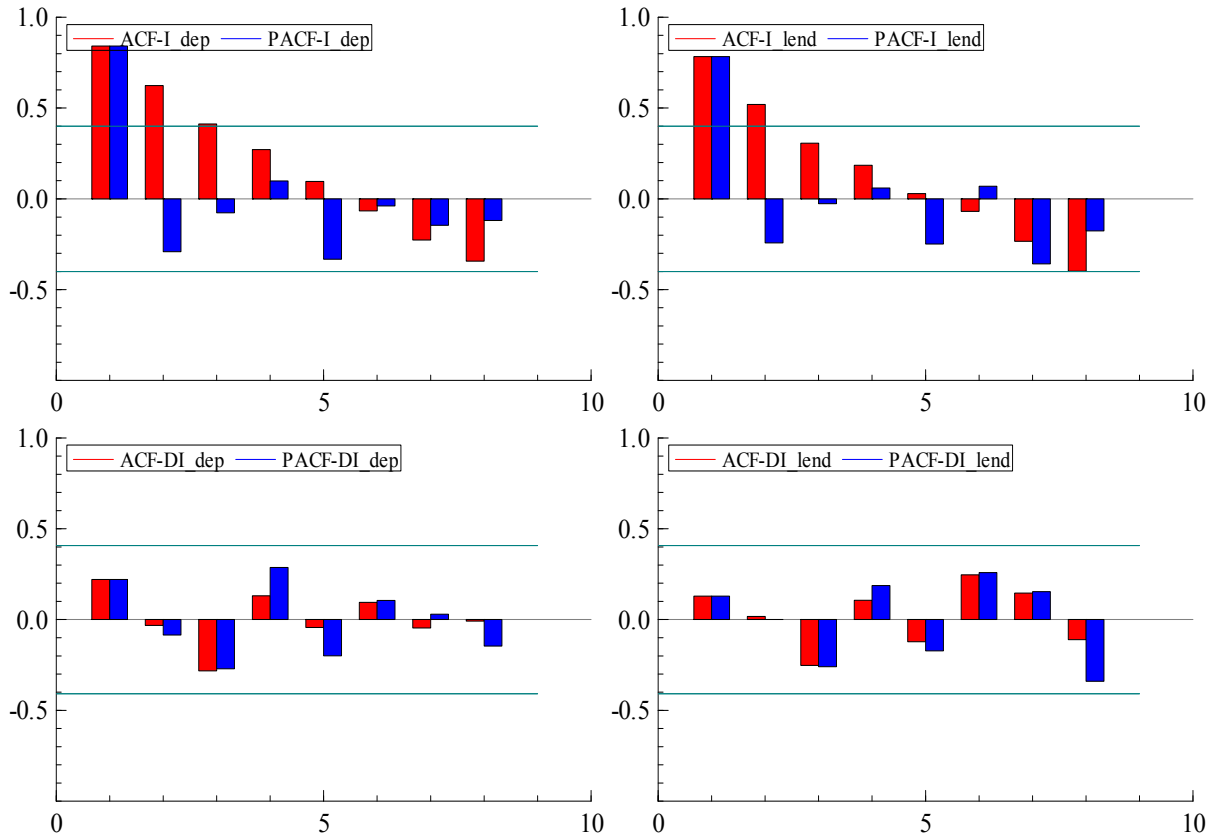
Values in parenthesis () are standard errors and values in square brackets [] are p-values.

Output gap

Our data on output include nominal GDP (valued at current price) from 1978-2004 (denoted as NY), and real GDP (index number with preceding year as 100) from 1978-2004. Just as what we've done with CPI, the above real GDP is converted to a base year series with 1977 constant price. We name it RY for real output. Output gap is then defined following the trend of modern business cycle analysis as the gap between log(RY) and its smoothed trend,

which is obtained by Hodrick-Prescott Filter⁷ and taken to be the potential level of real output. Since data are annual, the proper smoothing parameter should be $\lambda = 1600/44 = 6.25$, the fourth power of the change in observation frequency for data observed at a frequency different from quarterly. (see Lutkepohl, 2004; Ravn and Uhlig, 2001) And the derived series of output gap is then named GAP. Unit root test shows that GAP is stationary (see Table 1).

Figure 2-3 Interest rates: Deposit Rate vs. Lending Rate



(Output from PcGive)

⁷ Hodrick-Prescott Filter (HP Filter) is a popular tool used in business cycle analysis. It normally applies to a Trend Stationary Process (TSP) rather than a Difference Stationary Process (DSP). Denote the series by y_1, y_2, \dots, y_T , then HP filters specifies the trend of the series to be the component that solves the following minimization problem:

$$\min_{\mu_t} \sum_{t=1}^T \left\{ (y_t - \mu_t)^2 + \lambda [(\mu_{t+1} - \mu_t) - (\mu_t - \mu_{t-1})]^2 \right\}$$

where the parameter λ defines the smoothness of the filtered series (the trend).

Interest rate

There are data for two interest rates available, annual lending rate and annual deposit rate.⁸

Figure 2-3 plots the Autocorrelation Function (ACF) and Partial Autocorrelation Function (PACF) of the two interest rates and their first differences. All coefficients of the differenced series lie between the lines of significance, while the coefficients of the original series die out pretty quickly. Hence, the underlying autocorrelation functions and partial autocorrelation functions may be in line with transformed stationary processes. The ADF tests in Table 1 also fail to reject the null hypothesis of unit root for these two series. They can be regarded as I(1).

2.3.2 Test of Svensson's Model

Now that we have data ready, we set out to test the reduced form of Svensson's structural model. Though non-stationary, interest rate is still kept in the regression model as required by theory. Residuals are subsequently tested for unit root in order to make sure that the regression results are actually consistent.

Regression results are presented in detail in Table 4. To put it briefly, the model to be tested is

$$\pi_{t+2} = (1 + \alpha_1\beta_2)\pi_t + \alpha_1(1 + \beta_1)x_t - \alpha_1\beta_2i_t + (\varepsilon_{t+2} + \varepsilon_{t+1} + \alpha_1\eta_{t+1}), \text{ where } \alpha_1, \beta_1, \beta_2 > 0$$

And we have the following results:

$$[A-1] \quad \pi_t = \underset{(0.052)}{-0.054} - \underset{(0.644)}{0.746}\pi_{t-2} + \underset{(0.013)}{0.024}i_{t-2}^{***} + \underset{(1.046)}{0.317}x_{t-2}$$

$$R^2=0.2453 \quad F(3,18)=1.95[0.158] \quad DW=0.915$$

$$[A-2] \quad \pi_t = \underset{(0.082)}{0.008} + \underset{(0.482)}{0.232}\pi_{t-2} + \underset{(0.013)}{0.005}i_{t-2} - \underset{(0.966)}{0.797}x_{t-2}$$

$$R^2=0.1002 \quad F(3,18)=0.668[0.583] \quad DW=0.812$$

$$[A-3] \quad \pi_t = \underset{(0.036)}{-0.044} + \underset{(0.403)}{0.165}\pi_{t-1} - \underset{(0.427)}{0.436}\pi_{t-2}^{***} + \underset{(0.010)}{0.018}i_{t-1} + \underset{(0.009)}{0.001}i_{t-2} + \underset{(0.719)}{1.423}x_{t-1}^{***} - \underset{(0.791)}{1.184}x_{t-2}$$

⁸ In this chapter, we test the model with explanatory variables suggested by Svensson's original expression. But in fact, interest rate may not be an effective policy instrument in China. We'll look into this issue in later chapters.

$$R^2=0.7799 \quad F(6,15)=8.859[0.000]* \quad DW=1.78$$

$$[A-4] \quad \pi_t = \underset{(0.082)}{0.034} + \underset{(0.382)}{0.808} \pi_{t-1}^{***} + \underset{(0.453)}{0.010} \pi_{t-2} - \underset{(0.016)}{0.002} i_{t-1} - \underset{(0.010)}{0.001} i_{t-2} + \underset{(0.829)}{1.117} x_{t-1} - \underset{(0.904)}{1.947} x_{t-2}^{**}$$

$$R^2=0.7156 \quad F(6,15)=6.291[0.002]* \quad DW=1.72$$

Table 4 Regression Results with Svensson's Lag Structure

	A-1	A-2	A-3	A-4
	Pi	Pi	Pi	Pi
	(1982-2003/04)	(1982-2003/04)	(1982-2003/04)	(1982-2003/04)
Constant	-0.054(0.052)	0.008(0.082)	-0.044(0.036)	0.034(0.082)
Pi_1			0.165(0.403)	0.808(0.382)***
Pi_2	-0.746(0.644)	0.232(0.482)	-0.436(0.427)***	0.010(0.453)
I_dep_1			0.018(0.010)	
I_dep_2	0.024(0.013)***		0.001(0.009)	
I_lend_1				-0.002(0.016)
I_lend_2		0.005(0.013)		-0.001(0.010)
GAP_1			1.423(0.719)***	1.117(0.829)
GAP_2	0.317(1.046)	-0.797(0.966)	-1.184(0.791)	-1.947(0.904)**
Sigma	0.0632	0.0690101	0.0373868	0.0424992
RSS	0.0718962997	0.0857230463	0.0209666297	0.0270927776
R^2	0.245319	0.100183	0.779918	0.715613
F(k-1,n-k)	1.95 [0.158]	0.668 [0.583]	8.859 [0.000]*	6.291 [0.002]*
log-likelihood	31.7427	29.8078	45.2979	42.4782
DW	0.915	0.812	1.78	1.72
N	22	22	22	22
K	4	4	7	7
mean(Pi)	0.061749	0.061749	0.061749	0.06174
var(Pi)	0.00433033	0.00433033	0.00433033	0.00433033
ForecastCHSQ	0.42237 [0.5158]	0.00014458 [0.9904]	0.59651 [0.4399]	0.027311 [0.8687]
AR 1-2 test	10.443 [0.0013]*	14.862 [0.0002]*	1.0389 [0.3814]	0.86642 [0.4434]
ARCH 1-1 test	0.064777 [0.8023]	0.38849 [0.5419]	0.11201 [0.7432]	0.0015696 [0.9690]
Normality test	2.0905 [0.3516]	9.6085 [0.0082]*	0.87106 [0.6469]	11.417 [0.0033]*
Hetero test	1.1610 [0.3918]	2.0360 [0.1454]	0.15013 [0.9887]	0.27215 [0.9431]
RESET test	0.072768 [0.7906]	1.6357 [0.2181]	5.4000 [0.0357]**	0.91199 [0.3558]

Note: Predictive failure tests are conducted by breaking the sample at 2004. * significant at 1% level, ** significant at 5% level, *** significant at 10% level. Values in parenthesis () are standard errors and values in square brackets [] are p-values.

Regression function [A-1] uses deposit rate, while [A-2] uses lending rate. Both of them have a lag structure that is exactly the same as that of the reduced form above. We are interested in checking the sign and significance of lagged output gap and lagged interest rate.

The passing of normality test assures us of the validity of t- and F-tests. It is clear that the coefficients are not significant (t-statistics not significant), nor are the models as a whole (F-statistics not significant). We then include the full set of lags to get model A-3 and A-4, with deposit rate being used in the former case and lending rate in the latter.

The notable improvements in R-square suggest increased explanatory power with the inclusion of first lags. The F-tests also turn out to be significant. However, the regression results are not satisfactory in the sense that the sign and significance of certain coefficients are not what we've expected. An increase in deposit rate would encourage household to save more and spend less, while an increase in lending rate would dampen investment demand, both of which contribute negatively to the rate of inflation. Therefore, we are expecting negative signs for interest rates. However, coefficients of deposit rate in Model A-3 are positive and not significantly different from zero. The two-period-lagged inflation and the one-period-lagged output gap are significant, but only at 10% level. Coefficients of interest rate are negative in Model A-4, but they are not significant either. One-period-lagged inflation and two-period-lagged output gap are explanatory variables that are significant, at 10% and 5% level respectively.

2.3.3 China-specific Factors

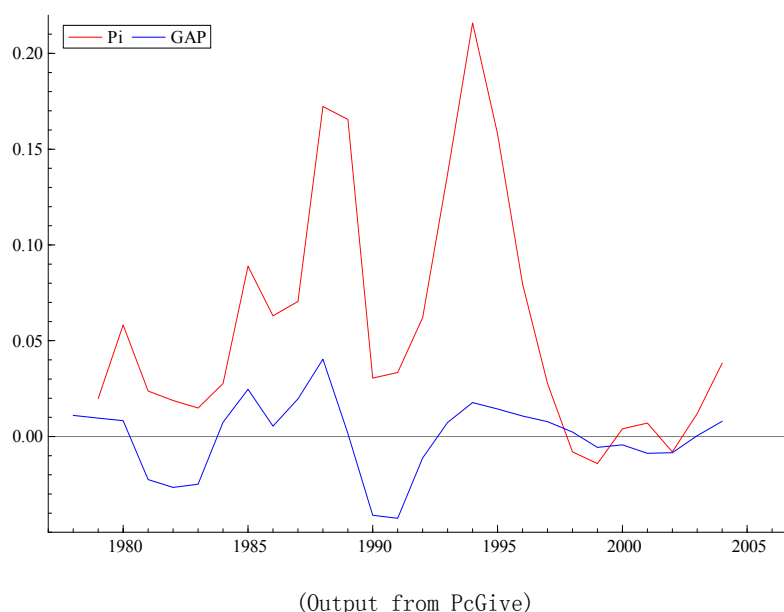
Given the above results, Svensson (1997) model doesn't seem to provide sufficient explanatory power to the inflation dynamics in China. Several possible China specific factors might have contributed to this result.

Historical events

Figure 2-4 plots inflation rate and output gap for the period from 1978 to 2004. The correlation between inflation and output gap no longer seems to be obvious after 1995, which indicates the existence of influences from factors other than aggregate demand. In order to find explanations for this phenomenon, we turn to the historical development of the corresponding period. China used to be a central-planning economy, with all the prices determined by the government. During the late 1970s and the beginning of 1980s, China gradually freed the prices and let them determined by market forces. The reform was finally completed at around 1994, when all the hidden inflationary pressure finally floated above the surface. It contributes to the severe inflation surge right afterwards, with the rate of inflation

rising up to a level as high as 24%. Another influential event would be the Southeast Asia Financial Crisis in 1997. China was then driven into a persistent deflationary period for about 2 years.

Figure 2-4 Inflation and Output Gap



Target and instrument

In standard inflation targeting framework, monetary authority should have no target other than inflation rate, neither exchange rate nor money growth; and the short term nominal interest rate should be a feasible instrument for the conduct of monetary policy. However, these assumptions may not apply within the Chinese context.

According to Leiderman and Svensson (1995), inflation targets normally play two roles:

First, as an anchor or coordination device for those involved in the price and wage setting process and in financial markets; and second, as a transparent guide to the national monetary and fiscal authorities' policy actions, clarifying their commitment to and accountability for the achievement of price stability.

Only with the absence of other targets can the commitment to low inflation be credible. However, China has more than enough reasons to be cautious in the setting of policy objectives. Neglecting certain objectives could entail tremendous loss to the society. Studies show that the introduction of inflation targeting framework can bring extra fluctuation in nominal interest rate and nominal exchange rate. If interest rate is assigned to the control of

domestic inflation, the exchange rate must be left freely floating. However, the Chinese currency, RMB, has been literally pegged to US dollar since the middle of 1990s and is believed to be highly undervalued at this moment. The expectation of appreciation has already given rise to the large volume of speculative capital inflows, leaving the country fairly vulnerable for large exchange rate fluctuations. What's more, the foreign exchange reserves of China, currently the largest around the world, are mostly dollar-denominated assets. If at this point we let the exchange rate float and RMB appreciates against US dollar as expected, the resulting loss of wealth would be enormous. Therefore, although the large trade surplus has put RMB under high pressure to appreciate, the Chinese government is still quite reluctant to make the change. In July 2005, China carried out a reform of the exchange rate, only announcing a gradual approach towards the floating arrangement. RMB is now pegged to a basket of major currencies with a somewhat secret recipe of its composition. And the nominal exchange rate is allowed to fluctuate within a ceiling and a floor per day. Since then, RMB has been appreciating gradually for about 3.5%, easing out the pressures from EU and US concerning the trade surplus, while at the same time allowing sufficient time for necessary internal adjustments. No matter how, given the current situation, China is obviously not ready to float the exchange rate, and the consideration of exchange rate stability is and will still remain on top of the list for any macroeconomic policy formulations.

Svensson's assumption of an effective interest rate instrument may also be violated in the Chinese case. China is not like the advanced economies, where the adjustments of short term interest rate are spread to long term rates through term structure on the money market. In China, as in most developing countries, there is a certain degree of financial repression inherited. Deposit rates and savings rates used to be controlled by the authority and kept lower than market level to boost economic growth. Interest rates are not determined on money market and can't be trusted in guiding the allocation of investment. However, interest rate liberalization has been gradually taking place in China, from foreign currency to domestic currency, from loans to deposits, from rural areas to cities, from long term to short term, transforming towards the direction of market mechanism. And People's Bank of China (PBoC), the central bank, did successfully curb inflation in late 1980s and at the middle of 1990s by raising interest rate. However, during the deflationary era after 1997, although PBoC cut the interest rate several times, the economy simply didn't respond and thus failed to be inflated. Fiscal policy took on the role afterwards. Therefore, in addition to the installation of the appropriate market structure, a market-oriented culture and corresponding institutional

environment are also crucial for the effectiveness of the interest rate instrument. And China still has a long way to go.

Demand and supply factors

In standard inflation targeting theory, the inflation generating process is assumed to be a demand-driven process. Supply shocks are assumed to be white noises while monetary and fiscal policy shocks determine the inflation dynamics through the so-called “aggregate demand channel”. This assumption might not hold in reality. And the recent forecast failures in several western inflation targeting countries undoubtedly serve as good examples. The fact that model-based inflation forecasts always turned out to be higher than the realized levels might be caused by their ignorance of the “China Effect”, the downward influence on general price level due to the large amount of cheap imports from China. Besides this, factors such as wage increase, surging oil prices and technological improvements are also common supply side factors that should be treated fairly. It is believed that supply side factors may have even larger impacts on developing countries. In light of this, Chand and Singh (2006) propose a broad-based structural model, including both supply and demand factors, from which they detect the supply-driven feature of the Indian inflation process. However, the existing literature on the nature of Chinese inflation dynamics are still quite limited and the conclusions mixed. Scheibe and Vines (2005), fitting data to a partially forward-looking hybrid Phillips Curve, shows that output gap, exchange rate and inflation expectations play an important role in explaining inflation, suggesting a process that is primarily demand driven. Some other studies (e.g. Bernanke 2002, Cargill and Parker 2004), however, claim that the change of inflation rate may primarily be driven by supply factors. For example, the strong productivity growth is thought to attribute to the era of persistent deflation. And another study conducted by Ha, Fan and Shu (2003) finds that world prices, the value of RMB and the level of productivity govern the long-run price movements in China.

Chapter 3 Inflation Dynamics in China

A conclusion is arrived in the previous chapter that Chinese data do not fit into Svensson's structure model. Given the fact that policy implications are model dependent, we don't think the interest rate rule derived in Chapter 2 to be directly applicable in China. Some China specific factors have been discussed thereafter to provide possible explanation to this result. In this chapter, an alternative model based on Chand and Singh (2006) is introduced and tested. We'll see why this model is considered an appropriate model for policy discussion in China.

3.1 Chand and Singh (2006) Model

In Chand and Singh (2006), a new inflation model combining demand and supply elements has been introduced. The model has several attributes. First of all, it gives an interpretation of the inflation generation process other than Svensson's Phillips-curve-type postulation. Second, by introducing fiscal policy into the scene, it might be more suitable for policy analyses in countries where interest rate is not yet an effective policy instrument.

The demand component of the model is presented as follows:

$$\pi_{t+1} = \pi_t + \alpha ed_{t+1} + \varepsilon_{t+1} \quad 3.1$$

$$ed_{t+1} \equiv y_{t+1} - ((1 + \pi_t)(1 + q_{t+1}) - 1) \doteq y_{t+1} - (\pi_t + q_{t+1}) \quad 3.2$$

$$y_{t+1} = c + \beta_1 Dd_t - \beta_2 D(i_t - \pi_t) + \eta_{t+1} \quad 3.3$$

$$(\alpha, \beta_1, \beta_2 > 0, \alpha \leq 1)$$

π_t is the inflation rate in period t ; y_t is the growth rate of nominal income, with GDP current price as proxy; ed_t , short for excess demand, is a nominally valued variable defined by Equation 3.2; \hat{q}_t is the real potential output growth rate, which is assumed to be a function of technology, labor and capital inputs and exogenous in the current short-term context; d_t denotes the deficit ratio, the ratio of deficit to GDP; and i_t still denotes the nominal interest rate. And as usual, D is the difference multiplier meaning first difference. All demand and supply shocks, ε, η in each period, are assumed to be i.i.d. The constant c corresponds to the

nominal growth rate in steady state, when inflation hits the target and real output grows at its potential.

The introduction of ed , nominal excess demand, is the third feature worth mentioning about this model. What contributes to inflation here is not real output gap as in Svensson's model, but this new variable ed . The definition of ed is given in Equation 3.2, where y_t denotes the growth rate of current sales income and \hat{q}_t denotes the potential growth rate of real output. Producers are assumed to have lagged expectations, expecting production cost to grow at previous period's inflation rate. Therefore, $((1+\pi_t)(1+\hat{q}_{t+1})-1)$ is the expected growth of nominal sales income when the economy expands at its potential level. ed is then the growth of nominal aggregate demand that is in excess of this expectation, which is believed to lead to price adjustments. Equation 3.1 clearly conveys the nature of this inflation generating process. First, whenever excessive nominal demand deviates from zero, there will be inflationary (deflationary when ed is negative) pressure imposed on the economy; otherwise, inflation will remain at the previous level. Second, a non-zero ed will not be fully reflected in inflation ($\alpha \leq 1$). Third, steady state is achieved when the economy grows at its potential level and inflation rate constant, which corresponds to ed being zero.

Equation 3.3 is a nominally valued aggregate demand function, which hypothesizes that the growth rate of nominal income is a positive function of the previous period's growth in fiscal deficit and a negative function of the change in realized real interest rate. In Chand and Singh (2006), this hypothesis is directly introduced into the model and subsequently tested to be approved.

From the above structure model, we can derive the following reduced form:

$$\pi_{t+1} = \pi_t - \alpha(\pi_t + \hat{q}_{t+1} - c) + \alpha\beta_1 Dd_t - \alpha\beta_2 D(i_t - \pi_t) + \alpha\eta_{t+1} + \varepsilon_{t+1} \quad 3.4$$

Now we solve the central bank's decision problem again. The objective function is not changed, but the restriction, the law of motion of this system, has changed to the above reduced form. The central bank's problem is:

$$\begin{aligned} \min_{\{Dd_t, Dd_t\}} E_t \sum_{\tau=t}^{\infty} \delta^{\tau-t} L(\pi_{\tau}) \\ \text{s.t. } \pi_{t+1} = \pi_t - \alpha(\pi_t + \hat{q}_{t+1} - c) + \alpha\beta_1 Dd_t - \alpha\beta_2 D(i_t - \pi_t) + \alpha\eta_{t+1} + \varepsilon_{t+1}, \forall t \\ \text{where } L(\pi_t) = \frac{1}{2}(\pi_t - \pi^*)^2 \end{aligned}$$

It is equivalent to the repetition of the following problems:

$$\min_{D i_t, D d_t} E_t \delta L(\pi_{t+1}) = E_t \frac{1}{2} \delta (\pi_{t+1} - \pi^*)^2$$

$$\text{s.t. } \pi_{t+1} = \pi_t - \alpha(\pi_t + \hat{q}_{t+1} - c) + \alpha\beta_1 D d_t - \alpha\beta_2 D(i_t - \pi_t) + \alpha\eta_{t+1} + \varepsilon_{t+1}$$

Taking first order conditions with respect to policy instruments (control variables):

$$\frac{\partial E_t \delta L(\pi_{t+1})}{\partial D i_t} = -\delta \alpha \beta_2 (E_t \pi_{t+1} - \pi^*) = 0 \quad 3.5$$

$$\frac{\partial E_t \delta L(\pi_{t+1})}{\partial D d_t} = \delta \alpha \beta_1 (E_t \pi_{t+1} - \pi^*) = 0 \quad 3.6$$

The optimal condition is therefore

$$E_t \pi_{t+1} = \pi_t - \alpha(\pi_t + \hat{q}_{t+1} - c) + \alpha\beta_1 D d_t - \alpha\beta_2 D(i_t - \pi_t) = \pi^* \quad 3.7$$

In order to achieve optimality, policy instruments should be set so that the forecasted inflation rate equals the inflation target.

Solving for instrument rules to get:

$$D i_t = D \pi_t + \frac{\pi_t - \pi^*}{\alpha\beta_2} + \frac{\beta_1}{\beta_2} D d_t - \frac{1}{\beta_2} (\pi_t + \hat{q}_{t+1} - c) \quad 3.8$$

$$D d_t = -\frac{\pi_t - \pi^*}{\alpha\beta_1} + \frac{\beta_2}{\beta_1} D(i_t - \pi_t) + \frac{1}{\beta_1} (\pi_t + \hat{q}_{t+1} - c) \quad 3.9$$

We now have two policy rules, one for interest rate and the other for deficit ratio. Rule 3.8 is similar to Rule 2.11 in the sense that nominal interest rate should be increased whenever the current inflation exceeds the target. However, the setting of interest rate in Rule 3.8 also responds to fiscal deficit and the growth of nominal income in excess of its steady state level c . When fiscal deficit stimulates excess demand, interest rate should be raised accordingly to offset the influence cast on the rate of inflation. Rule 3.9 requires for a reduction in fiscal deficit when inflation rate exceeds the target, and fiscal and monetary policies are also required to counteract each other.

According to the Mundell rule, we need to assign a single target to each instrument to ensure efficiency, and the target should be assigned to the instrument that has larger impact and less adverse side-effects on it. The one with relatively higher impact can be identified by comparing β_1 and β_2 in Equation 3.4. But as discussed in the previous chapter, given the importance of exchange rate stability in China at this moment, one can well argue that fiscal policy might stand out to be the proper choice among the two, due to its milder side effects.

3.2 Test of the Model Using Chinese Data

3.2.1 Effect of the Introduction of ed

We start with Equation 3.1, where we aim to check the effectiveness of the introduction of variable ed , or, the effectiveness of the alternative interpretation of inflation generation. The regression results are presented in Table 5 and the definitions of relevant variables are to be found in the Appendix.

In Model B-1, variable ed is defined according to equation 3.2. It is clear that the introduction of ed has improved the explanatory power of the model. The normality test fails to reject the null-hypothesis of normality, therefore, the OLS estimators can be considered unbiased and the t-tests and F-test valid. We find that the coefficients of lagged inflation and ed are both positive and highly significant. The rolling regression plots of the two explanatory variables also support significance across the entire sample (see Figure 3-1). However, the fact that the coefficient of lagged inflation exceeds unity indicates the possible existence of an upward bias.

Model B-2 defines another variable, $EDNP$, as the difference between nominal growth rate and real potential growth rate. This alteration has relaxed the assumption of inflation expectation formerly imposed on producers in the original Chand and Singh Model⁹. The

⁹ This model allows for heterogeneous composition in producers.

Suppose a proportion θ of the producers have static expectation, expecting the inflation rate to be the same as previous period, and the rest of producers have rational expectation.

The definition of excess demand is actually: $ed_{t+1} \equiv y_{t+1} - ((1 + \pi_{t+1}^e)(1 + q_{t+1}) - 1) \doteq y_{t+1} - (\pi_{t+1}^e + \hat{q}_{t+1})$

The expected inflation now is: $\pi_{t+1}^e = \theta\pi_t + (1 - \theta)\pi_{t+1}$, $0 \leq \theta \leq 1$

So, we have $ed_{t+1} \equiv y_{t+1} - ((1 + \theta\pi_t + (1 - \theta)\pi_{t+1})(1 + q_{t+1}) - 1) \doteq y_{t+1} - (\theta\pi_t + (1 - \theta)\pi_{t+1} + \hat{q}_{t+1})$

And from Equation 3.1, we have

$$\begin{aligned}\pi_{t+1} &= \pi_t + \alpha ed_{t+1} + \varepsilon_{t+1} \\ &= \pi_t + \alpha(y_{t+1} - \theta\pi_t - (1 - \theta)\pi_{t+1} - \hat{q}_{t+1}) + \varepsilon_{t+1} \\ &= (1 - \alpha\theta)\pi_t - \alpha(1 - \theta)\pi_{t+1} + \alpha(y_{t+1} - \hat{q}_{t+1}) + \varepsilon_{t+1}\end{aligned}$$

$$\Rightarrow \pi_{t+1} = \lambda_1 \pi_t + \lambda_2 EDNP_{t+1} + \mu_{t+1}$$

$$\text{where } \lambda_1 = \frac{1 - \alpha\theta}{1 + \alpha(1 - \theta)}, \lambda_2 = \frac{\alpha}{1 + \alpha(1 - \theta)}, \mu_{t+1} = \frac{\varepsilon_{t+1}}{1 + \alpha(1 - \theta)}, EDNP_{t+1} = y_{t+1} - \hat{q}_{t+1}$$

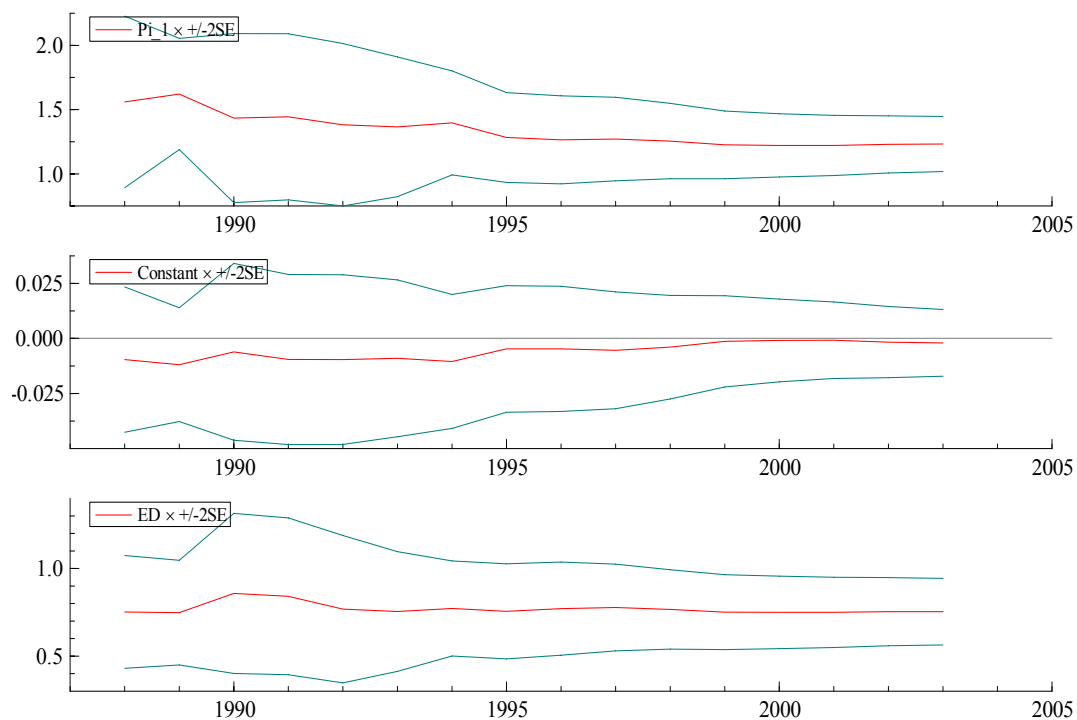
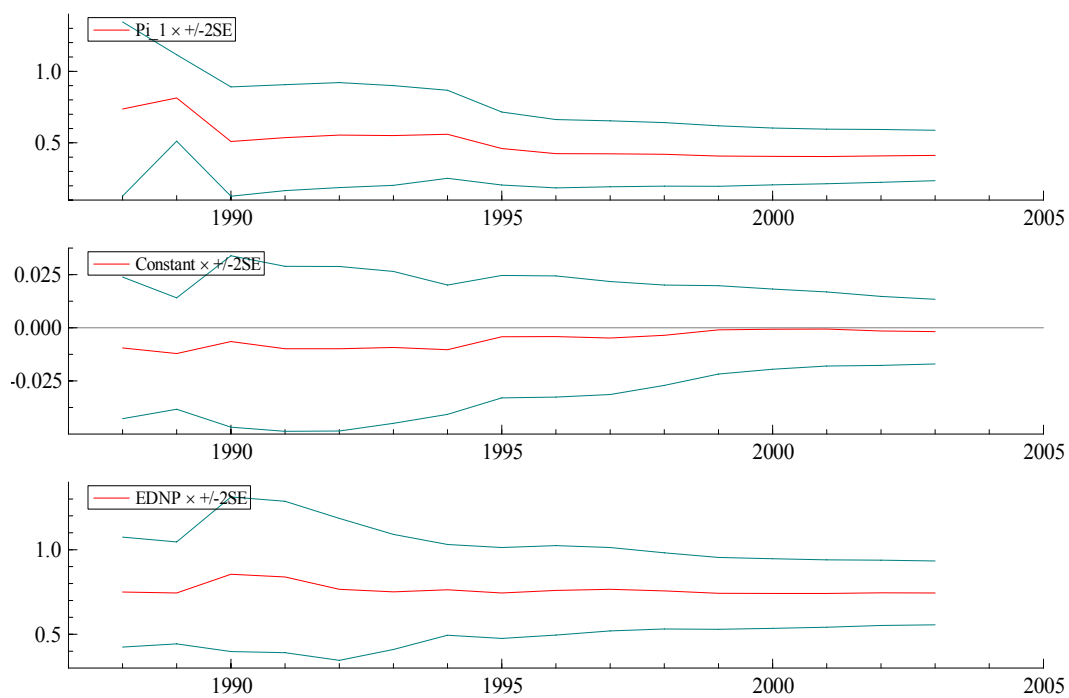
It is clear that $0 \leq \lambda_1, \lambda_2 \leq 1$. And when $\theta = 1$, it is reduced to the original specification.

regression result shows no significant improvement over Model B-1, implying the validity of the expectation assumption formerly imposed. The coefficient of *EDNP* is almost the same as the coefficient of *ed* in Model B-1. The coefficient of lagged inflation rate is reduced due to the change of variable from *ed* to *EDNP*. Rolling regression of coefficients can be found in Figure 3-2, suggesting significance over the entire sample.

Table 5 Test of the Alternative Formulation

	B-1	B-2	B-3	B-4	B-5
	Pi	Pi	Pi	Pi	Pi
	(1982-2003/04)	(1982-2003/04)	(1982-2003/04)	(1982-2003/04)	(1982-2003/04)
Constant	-0.004 (0.008)	-0.004 (0.008)	0.003(0.013)	-0.133(0.085)	0.026(0.095)
Pi_1	1.249 (0.111) *	0.421 (0.091)*	0.909(0.128)*	0.516(0.177)**	0.581(0.153)*
ED	0.761 (0.099) *				
EDNP		0.752(0.099)*			
DGAP			1.776(0.521)*		
DLRYHP				1.807(0.914)***	-0.128(1.055)
Dpi_1				0.409(0.294)	0.549(0.266)***
DI_lend_1				-1.695(2.057)	0.699(1.924)
DDR_1				0.082(1.598)	-0.283(1.335)
DI_dep_1				0.963(1.921)	-1.519(1.857)
DLM2GAP_1					0.453(0.245)***
DLREER_1					-0.171(0.084)***
Sigma	0.0256	0.0258	0.0408	0.0451	0.0372
RSS	0.0125	0.0126	0.0317	0.0306	0.0180
R^2	0.869	0.8676	0.6674	0.6792	0.8112
F(k-1,n-k)	63.02 [0.00]*	62.25 [0.00]*	19.06 [0.00]*	5.292 [0.00]**	6.982[0.00]**
log-likelihood	51.0047	50.8876	40.7542	41.1513	46.9839
DW	1.63	1.62	1.72	2.04	1.99
n	22	22	22	22	22
k	3	3	3	7	9
mean(Pi)	0.0617	0.0617	0.0617	0.0617	0.0617
var(Pi)	0.0043	0.0043	0.0043	0.0043	0.0043
ForecastCHSQ	0.38428 [0.54]	0.35843 [0.55]	0.0613 [0.80]	0.0318[0.86]	0.0075[0.93]
AR 1-2 test	1.4532 [0.26]	1.4859 [0.25]	0.9502 [0.41]	1.3733 [0.29]	6.9618[0.01]*
ARCH 1-1 test	6.9904 [0.02]**	6.7450 [0.02]**	2.9633 [0.10]	0.2106 [0.65]	0.0547[0.82]
Normality test	3.1884 [0.20]	3.4885 [0.17]	1.6064 [0.45]	5.1909 [0.07]	23.103[0.00]**
hetero test	2.6315 [0.08]	1.3728 [0.29]	4.1697 [0.02]**	0.0927 [0.998]	n.a.
RESET test	1.5753 [0.23]	1.2736 [0.27]	0.2278 [0.64]	0.0950 [0.76]	0.0008[0.98]

Note: Predictive failure tests are conducted by breaking the sample at 2004. * significant at 1% level, ** significant at 5% level, *** significant at 10% level. Values in parenthesis () are standard errors and values in square brackets [] are p-values.

Figure 3-1 Rolling Regression of Model B-1**Figure 3-2 Rolling Regression of Model B-2**

(Output from PcGive)

Model B-3 instead uses the parallel concept of first difference of output gap, $DGAP$ ¹⁰. The estimated coefficients are still highly significant, but the R-square of the model has been significantly reduced. This is probably because of the unavoidable loss of information involved in the statistical reporting in real terms. Therefore, Model B-3 is not preferred to the other two and Model B-2 is our favorite among the three.

3.2.2 The Demand Side

Model B-1, B-2 and B-3 show that the interpretation of inflation being triggered by nominal excess demand has more explanatory power over the traditional Phillips curve interpretation. Now, we move on to the estimation of the reduced form equation 3.4, with exactly the same lag structure as specified. If the policy instruments are significant, we would be able to derive optimal policy rules accordingly. However, as presented in Model B-4,

¹⁰ The variable $DGAP$ is a concept parallel to ed .

We know that $GAP_t = LRY_t - LRYHP_t$ and $\ln(1+x) \doteq x$.

Therefore, we have:

$$\begin{aligned}
 DGAP_t &= GAP_t - GAP_{t-1} \\
 &= (LRY_t - LRYHP_t) - (LRY_{t-1} - LRYHP_{t-1}) \\
 &= (LRY_t - LRY_{t-1}) - (LRYHP_t - LRYHP_{t-1}) \\
 &= \ln \frac{RY_t}{RY_{t-1}} - \ln \frac{RYHP_t}{RYHP_{t-1}} \\
 &= \ln \left(1 + \frac{RY_t - RY_{t-1}}{RY_{t-1}} \right) - \ln \left(1 + \frac{RYHP_t - RYHP_{t-1}}{RYHP_{t-1}} \right) \\
 &\doteq \frac{RY_t - RY_{t-1}}{RY_{t-1}} - \frac{RYHP_t - RYHP_{t-1}}{RYHP_{t-1}} = (y_t - \pi_t) - \hat{q}_t
 \end{aligned}$$

That is, $DGAP$ can be interpreted as the gap between actual real output growth ($y_t - \pi_t$) and the potential real output growth (\hat{q}_t). The former normally can be directly obtained from reported statistics, but there might be information loss involved due to statistical errors.

It is easy to find that $EDNP_{t+1} = DGAP_{t+1} + \pi_{t+1}$

Then Model B-2 can be written as $\pi_{t+1} = \lambda_1 \pi_t + \lambda_2 EDNP_{t+1} + \mu_{t+1} = \lambda_1 \pi_t + \lambda_2 (DGAP_{t+1} + \pi_{t+1}) + \mu_{t+1}$

$$\Rightarrow \pi_{t+1} = \pi_t + \frac{\lambda_2}{\lambda_1} DGAP_{t+1} + \frac{\mu_{t+1}}{\lambda_1}$$

Note that in Table 5, the coefficient for $DGAP$ in model B-3 exceeds unity, which corresponds to the fact that the coefficient λ_2 is larger than λ_1 in the regression of model B-2.

neither the lagged change of deposit rate nor the lagged change of deficit ratio turns out to have significant influence on current rate of inflation. To find out the determinants of nominal excess demand is therefore our next crucial step, since we need it to identify and quantify the scope for demand management.

According to Keynesian tradition, there are four components of aggregate demand for an open economy. They are consumption, investment, government expenditure and net exports. For domestic demand, interest rates and money stock are conventionally recognized as monetary policy instruments, while fiscal deficit ratio is considered the proxy for fiscal policy. For external demand, we choose Nominal effective exchange rate (*NEER*) as an explanatory variable. *NEER* is the weighted average of major bilateral nominal exchange rates, with weights determined by trade shares reflecting different level of importance of each currency in a country's international trade. It is a widely used index to assess competitiveness, reflecting the changes in trade flow induced by exchange rate. Real effective exchange rate (*REER*) is obtained by adjusting *NEER* for inflation differentials with those countries. Since the inflation rate in each country is assumed to broadly indicate the trends in domestic costs of production, *REER* is expected to reflect foreign competitiveness of domestic products. An appreciation, more foreign currency per unit of domestic currency, is considered unfavorable for exports. After several trials, we arrive at Model B-5 as presented in Table 5. It is clear that the inclusion of new variables has improved the explanatory power of the model. (R-square has increased to more than 0.8.) Several points need to pay attention to in this result. First, the growth rate of *REER* has a negative coefficient, the same as what we've expected. And it is significant at 10% level. Second, we've introduced variable *DLM2GAP* to capture the influence of excess money growth, separating the discretionary part from PBoC's target of money growth. The coefficient is positive and significant in 10% level. Third, neither interest rates nor budget deficit appears to be significant. But given the knowledge of money supply generation, it could be that the inclusion of excess growth of money has reflected their influences already. Finally, note that deposit rate and lending rate have opposite signs. It is mystic on the first sight with conventional theories in mind which claim that both of them should have a negative sign obtained. Just think that higher deposit rate would pose liquidity constraint on the economy, negatively affecting expenditure, and that higher lending rate would discourage loan applications and reduce investment. However, it is possible in this case, since money growth is another explanatory variable included in the regression, which is held constant when measuring the influences of interest rates.

3.2.3 The Supply Side

As mentioned in the previous chapter, several studies have identified supply side influences in the Chinese inflation dynamics. Therefore, the monetarist approach may not be broad enough to model the inflation movements. We now turn to the supply side, considering the possibility of cost pushed inflation and the influence of technological advances.

It is assumed that the general price level in the economy is set as a markup on average marginal cost, which is the weighted average of marginal costs of all input factors. To present it mathematically, we have:

$$P_t = A_t \prod_{i=1}^n X_{it}^{\alpha_i}, \text{ where } \sum_{i=1}^n \alpha_i = 1$$

The environment of this model economy is simple, with only one firm producing one goods from n different input factors. The price level in period t is P_t . And the i^{th} factor involved in the production process accounts for a share of α_i in the total cost, with X_i as its cost. A_t is the markup for time t, and is assumed to be constant over time. However, we need to keep in mind that it might vary due to environment changes such as productivity improvements or price competition.

Taking logs, we get:

$$\ln P_t = \ln A_t + \sum_{i=1}^n \alpha_i \ln X_{it}$$

Then take first difference to get:

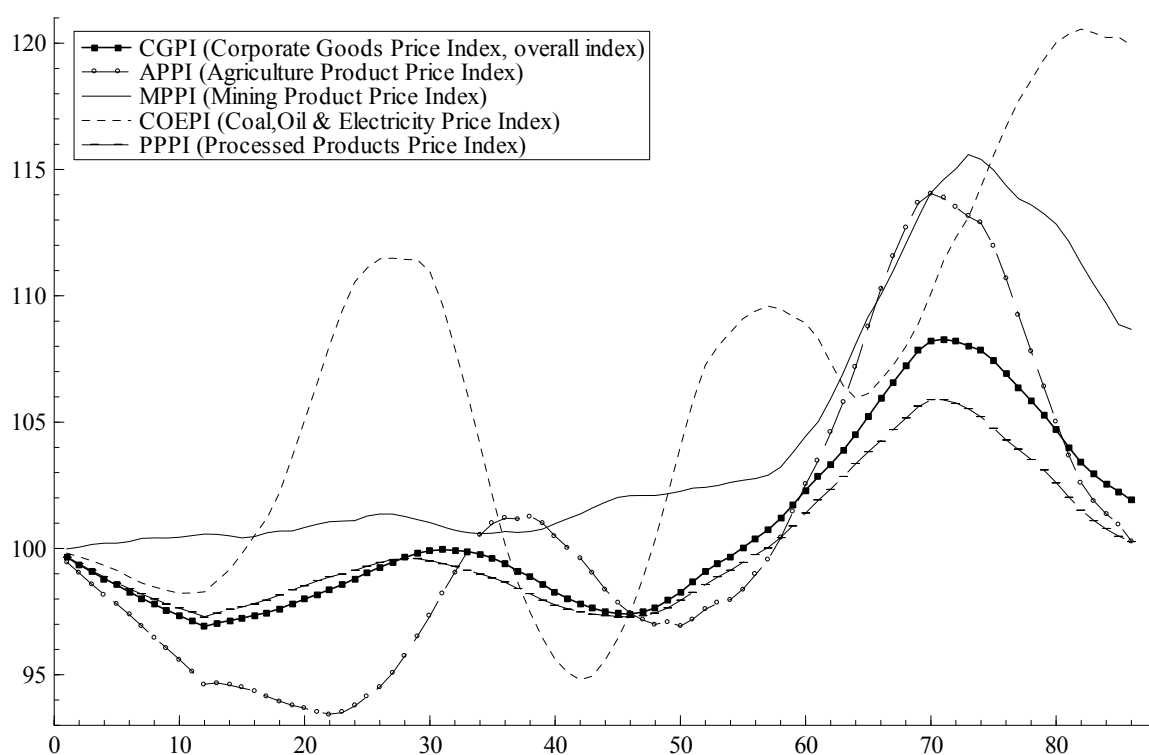
$$P_i = a + \sum_{i=1}^n \alpha_i x_i$$

The rate of inflation can be interpreted as a weighted average of the cost inflation of different input factors, and is also influenced by the growth rate of profit margin, a . However, within an economy-wide context, it is always very hard for us to obtain information as tailored as we need. Improvements in statistics do help, for example, the Corporate Goods Price Index (CGPI) published by PBoC in recent years might be a better choice for our study compared with CPI, but we need to stick to CPI inflation here due to the absence of CGPI in early years of our sample¹¹. To capture the influences from costs, we need to search for some key variables, which are both sensitive and important in the production process. An

¹¹ CGPI has been published monthly by PBoC since 1996, with easy access from PBoC website for data after 1999. CGPI used to be called Wholesale Price Index (WPI), indicating the general price level right after production. CPI is different in the sense that it is the price level faced by consumers. Considering the possibility that retailers might not be willing to increase prices due to competition in the retail industry, (which is highly possible and definitely applicable in China where retailers care very much about their market share), CGPI is a more proper choice when analyzing cost pushed inflation. However, due to un-accessibility of sufficiently long series of annual CGPI, we have no other choice but to use CPI inflation in our analysis.

exploration of the available monthly CGPI data can surely shed some light on it (see Figure 3-3). The overall index of CGPI is published together with price indices of its key components, including Agricultural Product Price Index (APPI), Mining Product Price Index (MPPI), Coal, Oil & Electricity Price Index (COEPI) and Processed Products Price Index (PPPI). We can see that PPPI has the least fluctuations around the overall index, while energy price COEPI and food price APPI appear to be highly volatile. These observations can serve as guidelines in choosing proxy for our analysis.

Figure 3-3 CGPI (Corporate Goods Price Index) and Its Components (1999.01 - 2006.02)



Note: The original data are reported as index with respect to the corresponding month of the previous year. Therefore, the original data are transformed to moving average of previous 12 months to assure comparability across the sample. (source: PBoC)

Regression result for the supply side is presented as Model C-1 in Table 6. Growth rate of nominal wage (DLNW) is defined as the first difference of the logged nominal wage index of an average employer. It captures the general increase in labor costs. Growth rate of fertilizer price (DLFP) is employed to represent the cost increase in agriculture. And the world oil prices (DLWOP) is introduced to reflect the rising cost of energy. Several specifications are tested, but none of them have DLNW and the first lag of NLWOP significant. The only

significant variable is DLFP. This can be explained by the following three facts. First, the Chinese government has tight control over domestic energy prices and the domestic energy price is not synchronized with the world out there. A base price is set by the Reform and Development Committee, which is then constantly adjusted to incorporate fluctuations of world oil prices, but there are always other domestic considerations embedded in the adjustments. DLWOP therefore has no significant influence on domestic CPI inflation. Second, CPI inflation is not sensitive to labor costs either. It echoes with the discovery of labor-cost insignificance in India (Chand and Singh, 2006). A phenomenon like this could be caused either by the lack of adjustments in wage itself, or by the reluctance of retailers to increase prices. To put it another way, one reason for this is that the labor cost itself hasn't changed much across the sample, arguably due to the seemingly infinite supply of labor. Another possible reason is that even if manufacturing companies did pay out more money to cover their labor cost, the price faced by final consumers were not increased. It can be explained by the importance of market share and the growth in productivity. On one hand, because of the huge market potentially available, even a moderate market share can be translated into a large volume, and even a small margin can make a profitable business. If increasing price undermines market share, they'd rather shrink the markup and play it safe. On the other hand, TFP has been rising at an average rate of 2-3% per year, way faster than the 1% of East Asian tigers at the same stage of their development during 1960-1984. Technological improvements make it possible to produce more goods with one unit of labor, which cancels out the effect of wage increase on the price of final goods. Third, DLFP is highly significant, reflecting the government's attitude towards agriculture. Because of the necessity of agriculture production and the still-high proportion of rural residents, food prices are sensitive to agricultural costs, in order to maintain sufficient profit margin to keep the farmers' lives sustainable.

Model C-2 is a regression combining the supply- and demand- side variables. When considered together with demand side factors, even the only significant supply-side variable becomes insignificant. A test of excluding the three supply side variables is then carried out to improve the model. The result supports exclusion.

We finally arrive at Model C-3. Current domestic inflation can be explained by previous inflation and contemporaneous nominal excess demand. Lagged trade condition REER is also included in the model to take into account external demand. The R-square is pretty high, indicating a strong explanatory power of the model. Based on the above result, the inflation

dynamics of China is largely a demand-driven process. However, we need to keep in mind that the insignificance of supply side variable might also be caused by poor proxy. And even if it is true that supply-side factors don't count much in the historical movement of inflation, it does not necessarily mean insignificant influence in the future. Therefore, adopting this alternative approach is a better way to understand the nature of inflation than the previous monetarist way, where demand-driven inflation is taken for granted.

Model C-3 gives us support on the potential possibility of inflation management through aggregate demand channel. However, we've learned from Model B-4 that both interest rates and fiscal deficit have insignificant influence on the rate of inflation. Another regression has actually been carried out, with nominal excess demand as the dependent variable. But none of them are found significant either. Then, what is the source of nominal excess demand? What is the proper way to formulate demand influences? These are issues following up in the next chapter.

Table 6 Regression Results with Supply Side Variables Included

	C-1	C-2	C-3
	Pi	Pi	Pi
	(1983-2003/04)	(1983-2003/04)	(1983-2003/04)
Constant	0.004(0.023)	-0.022(0.018)	-0.008(0.007)
Pi_1		0.467(0.118)*	0.490(0.083)*
EDNP		0.373(0.064)***	0.632(0.097)*
DLNW	0.261(0.184)	0.172(0.156)	
DLFP	0.473(0.111)*	0.085(0.115)	
DLWOP_1	0.004(0.035)	0.024(0.026)	
DLREER_1		-0.174(0.064)**	-0.130(0.049)**
Sigma	0.0372	0.0234	0.0225
RSS	0.0235	0.0077	0.0091
R^2	0.7479	0.9180	0.9046
F(k-1,n-k)	16.81[0.000]*	26.13[0.000]**	56.92[0.000]**
log-likelihood	41.5398	53.3338	54.4972
DW	1.55	1.64	1.62
N	21	21	22
K	4	7	4
Mean(Pi)	0.0637932	0.0637932	0.061749
var(Pi)	0.0044446	0.0044446	0.0043303
ForecastCHSQ	2.3823[0.1227]	0.65422[0.4186]	0.26267[0.6083]
AR 1-2 test	0.96668[0.4028]	2.2271[0.1505]	2.8358[0.0883]
ARCH 1-1 test	0.51378[0.4845]	5.7788[0.0333]*	12.503[0.0027]**
Normality test	0.33232[0.8469]	0.65117[0.7221]	0.18761[0.9105]
Hetero test	0.31243[0.9162]	0.0980[0.9923]	0.82846[0.5716]
RESET test	0.29132[0.5968]	10.332[0.0068]**	8.6890[0.0090]**

Note: Predictive failure tests are conducted by breaking the sample at 2004. *significant at 1% level, **significant at 5% level, *** significant at 10% level. Values in parenthesis () are standard errors and values in square brackets [] are p-values.

Chapter 4 Inflation Management in China

The finding of our empirical analyses up till now conveys two key points:

First, Svensson's structural model doesn't fit the data well. This could probably be caused by misspecification of demand-side influences as they apply in China or the neglect of supply side factors in the inflation generating process. By testing the alternative Chand & Singh model, which takes both sides into account, we find that cost inflation really hasn't played a significant role in the Chinese inflation dynamics. The ineffectiveness of Svensson's model may be caused by improper formulation of demand-side influences.

Second, the result indicates significant influence from the external sector captured by the growth of Real Effective Exchange Rate (REER). Given the significance of nominal excess demand in the inflation dynamics, there is scope for demand management policy in inflation control in China, and thus a potential possibility of adopting inflation targeting framework. However, neither fiscal deficit nor interest rates appear to be significant determinants of nominal excess demand. Instead, excess growth of M2 (DLM2GAP) is found significantly correlated with current rate of inflation, lagging for one period.

What is the reason behind the insignificance of those policy instruments? What is the source of nominal excess demand in China? When can the applicability of Inflation Targeting Framework change from potential to reality? And what's the way ahead for China to manage its inflation and assure a favorable environment for its sustainable growth? These are the problems to be addressed in this chapter.

4.1 Behind the Ineffective Interest Rates

The ineffectiveness of interest rates in China is largely due to the badly functioning banking system, which disconnects the transmission mechanism that is commonly exhibited in the well-developed economies. In China, credit is allocated with relatively less regards to its price and a relatively higher degree of government meddling. Besides, home mortgage and consumer loan are still in their infancy. Therefore, the deregulation of interest rates and the reform of banking sector are crucial to China's future development. China cannot afford an abrupt change towards floating exchange rate without first clearing up the banking sector.

There's still a long way to go before the right time comes for China to build up a standard inflation targeting framework.

4.1.1 Financial System in China: Past and Present

Pre-1979

The chief tasks of any financial system are to attract savings and channel them to productive investments as efficiently as possible. However, there was no such concept of banking in the highly centralized pre-reform Chinese economy. Banks were merely planning machines that took whatever the state-owned enterprises (SOEs) had earned and reallocated them through budgetary grants. The allocation decisions were made in accordance to SOEs' self-reported production plans, which were inefficiently upward-biased due to SOEs' desire for more funding. A strong government made all the decisions, which left the individuals incompetent to pursue their own benefits and bankers too ignorant to understand the true meaning of banking. The opening-up policy of 1978 is a cutting point in the history of China's development, when China launched the plan to abandon central planning. However, it is not an easy job to cultivate a market-oriented culture out of the deep-rooted central-planning customs. The banking system in China is still relatively weak, even among the developing countries alike.

1979-1994

The monopolistic position held by PBoC was removed in 1979, arguably the first move in China's banking reform. Three specialized banks were established to take over PBoC's banking business. They are Agriculture Bank of China (ABC) for rural banking, Bank of China (BOC) for foreign currency transactions, and China Construction Bank (CCB) for the construction sector. A fourth specialized bank, Industrial and Commercial Bank of China (ICBC), was established in 1984, taking over all the urban commercial banking activities from PBoC in 1994, when PBoC finally get on board for the central bank's role. Several other banks were also established during the 1980s, including the state-owned China Investment Bank (1981), the joint-stock Bank of Communications (1986), and CITIC Industrial Bank (1987) owned by China Investment and Trust Corporation.

It was mainly a period for institutional buildup, at the end of which a two-tiered banking system was established, with People's Bank of China (PBoC) transformed to a central bank and four specialized banks taking charge of different areas in the economy.

1994-present

Financial reforms have been carried out continuously since the 1990s. According to a report from Asian Development Bank (Shirai and Rajasekaran, 2001), the major financial reforms from 1994 were centered on separating commercial lending and policy lending, transforming the four specialized banks and the urban credit cooperatives into commercial banks and establishing three policy-lending banks and new commercial banks. Other reforms were the removal of credit plans, reduced government intervention in credit allocation, (limited) entry deregulation, a narrowing of the scope of business, (limited) interest rate deregulation, tightened accounting and prudential norms, and financial sector restructuring. But the current financial system is still highly underdeveloped in the sense that it is still dominated by banks, and the debt and equity markets are among the smallest in the world.

4.1.2 Interest Rates in China

As for interest rate deregulations, banks were allowed to adjust lending rates within a certain margin below and above the administered rate in the late 1980s, while such flexibility on deposit rates was not granted. Later on, in 1989, an austerity program was carried out reversing this liberalization process until the early 1990s. When the program ended, banks were allowed to set interest rates again, still with ceilings and floors around the administered rate, but the margin was gradually expanded. In 2004, the ceiling on lending rates for banks and the floor on deposit rates were finally removed, opening up for more lending to private businesses, particularly smaller ones. The floor on lending rates is said to be gradually removed, starting from 2006, while the ceiling on deposit rates will remain until 2008 to 2010. The rationale is that this delay will prevent bank margins from declining too rapidly when foreign competitors enter the market at the end of 2006, as was scheduled by China's entry commitment to WTO.

However, Chinese banks lack credit risk assessment skills required for effective lending. They are risk-averse in nature and feel more secure lending to SOEs or government-related projects, which is a typical symptom of central planning syndrome. The fact that commercial

banks in small rural areas always belong to local government even adds to the problem. First, the lack of standard risk-assessment procedure makes them vulnerable to political influences from local government officials. Second, local governments tend to direct capital to SOEs even if they are less productive. They do so in the fear of social disturbances possibly resulted from large scale SOE layoffs. And local construction projects can always get cheap finance, which contributes to the apparent overheating investment boom in China. Therefore, despite the general trend towards deregulation, SOEs and government-related projects still appear to get the majority of lending from banks and add to the already problematic nonperforming loans. Small private business and entrepreneurs, on the other hand, have to turn to informal banking sector and pay for a higher rate.

The inefficient allocation of capital and the declining capital return lead to low deposit rates. But thanks to the traditionally acclaimed habit of savings, banks continue to enjoy a low-cost source of money from depositors. The Chinese people, having a natural urge to save no matter what, still have their savings account for almost 40% of GDP and are relatively less sensitive to changes in deposit rates due to lack of alternatives for their portfolios, i.e. the lack of healthy equity and corporate-bond markets and the lack of other options such as insurance and mutual funds. And there is a fraction of population illiterate in economic sense who even won't aware of the fact that they are losing money when interest rates falls below the rate of inflation. Therefore, banks in China generally face little competition in attracting savings.

4.1.3 The Financial System in China: Future

The banking sector in China has till now been quite successful with the task of attracting savings - though largely due to reasons other than their own merits – but relatively less efficient in the allocation of these capital. With the foreseeable competition coming from foreign competitors, the current situation is expected to change.

At this moment, foreign banks have relatively few branches in China and the areas of business allowed are still limited to foreign currency denominated financial services. However, foreign banks will be allowed to enter domestic currency market in December 2006. Although it will take considerable time for them to grow organically, their impact on domestic commercial banks will be immense. First, the flow of deposits currently safely coming in will be disturbed by alternative options bearing higher return. Second, the lack-of risk-assessment-skill problem will become a vital flaw of domestic financial intermediaries,

gradually depriving them of the market share and the customer loyalty they are now enjoying. However, the bright side is even more attractive in the long run. The efficiency of the banking sector as a whole is bound to improve. And the interest rate deregulation will be expected to take a big step forward. If the lending rate is liberalized in conjunction with the reform of corporate-bond market, interest rates will become effective candidates for monetary policy instruments. Given the significantly demand-driven nature of the Chinese inflation generating process, it is possible to adopt Inflation Targeting Framework when effective policy instruments become available.

4.2 Exchange Rate Regime and Monetary Autonomy

Since the exchange rate in China has remained fixed during most of the sample period, the analyses in previous chapters are mainly based on closed economy model, and an effective exchange rate variable was introduced to control for influences on the inflation rate from the external sector.

However, the flexibility of exchange rate is an important prerequisite for the formulation of optimal monetary policy under ITF, without which there is actually no monetary autonomy. When pegged to US dollar and facing a strong RMB appreciation pressure, central bank had to frequently and passively absorb excess supply of US dollar to clear the market and maintain the peg, leaving a variety of problems in the enforcement of monetary policy.

After the July 21 Reform of 2005, when RMB appreciated 2.1% against US dollar and replace the dollar-peg by a reference basket consisting of several major currencies, it is still the case since the country is still trying hard to maintain exchange rate stability. Whenever there is excess supply of foreign currency on the foreign exchange market, PBoC will have to sell yuan in order to keep the exchange rate stable. This means injection of new liquidity into the banking system. Theoretically speaking, it is possible for PBoC to issue bonds and mop up the liquidity, a strategy commonly known as sterilization. But as the amount accumulates, sterilization is getting harder and harder, especially facing the huge build-up of foreign reserves. When the bank fails to sell enough bonds, money supply will surge and give rise to demand-driven inflation. It is widely accepted that the RMB is undervalued, and the 2005 appreciation even lured in more hot money. The speculative capital inflows expose the country to huge exchange rate risks. Therefore, it would be unwise for China to float the exchange rate at this stage. We can expect a gradual approach for this reform.

4.3 Policy Implications for China

It is clear that in the long run, Inflation Targeting Framework would be an appropriate choice for China's monetary policy formulation given the demand-driven nature of inflation generating process. However, ITF is not a proper choice in the short run. With the not yet deregulated exchange rate regime, the not yet freed capital account, and the persistent weakness of the financial sector, adopting ITF immediately can be a highly destabilizing choice. Recall the discussed in Chapter 3 that assigning interest rates to the objective induces large side effects, we might consider fiscal policy as an alternative. A strategy is proposed in Chand & Singh (2006) for India to use interest rates as an exchange rate stabilizing tool, while relying more on fiscal discipline for inflation stabilization. Given the similarity between the two countries, we may expect the same result for China.

Actually, China started using proactive fiscal instruments in 1998, when monetary policy failed to stimulate the economy during the persistent deflationary period after the 1997 Asian Financial Crisis. Fiscal deficit has increased dramatically in the past few years, spending on infrastructures and construction projects, improving 'hardware' of economic development and contributing to the continued growth of Chinese economy. It is argued that fiscal policy has contributed a lot to the appearance of overheating. Concerned with the problem, the central government has recently announced an appeal for prudent fiscal policy. Just as an official presented, "the central government wants to send a message of the direction of macro-control to the public through its fiscal policy, that is, to prevent more symptoms of inflation and the emergence of deflation, by cutting down the deficit in the central budget."

But to rely on fiscal instruments is at best a temporary strategy. Several reforms should be carried out during this temporarily fiscal-dominated period to prepared for future adoption of the inflation targeting framework:

First, the reason why interest rate cuts failed to stimulate the economy during deflation is not only the love of savings. When considering basic human needs, we'll have a deeper understanding of the problem. The urge to save is basically coming from the pursuit of security. Therefore, if an effective social security system isn't in place and employment isn't secured with the presence of surplus labor, it is natural for households to save. Therefore, social security reform should be launched to clear up this channel, and it should be ranked high on our agenda.

Second, with the competition from foreign banks that will enter RMB denominated business after 2006, the efficiency of the banking system would be increased. In the previous

arrangement, when domestic commercial banks are highly protected, it is very difficult for private business and small entrepreneurs to get credit from the banking system. They have to turn to informal banking sector for funds, which always ends up with higher costs. At the same time, less competent SOEs and government related projects continued to enjoy cheap finance. However, in a more competitive environment, domestic banks need to make more accountable lending decisions with the help of credit-rating organizations and risk management skills. Given its importance, to build up a credit rating system is also crucial for an effective policy framework in the future.

And finally, since optimal policy is model dependent, it is also a necessary preparation for Chinese monetary authority to master the skill of economic modeling and for statistical agencies to improve the quality of data. When ITF is finally implemented, these factors will be crucial for the credibility of monetary policy and greatly influence the effectiveness of this type of inflation management.

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Appendix

* Variable names and acronyms are listed in alphabetic order.

* The general denotation rule for variable X:

X_n: variable X lagged for n periods

DX: $DX = X - X_{-1}$

LX: $LX = \ln(X)$

DLX: $DLX = LX - LX_{-1} = \ln(X/X_{-1}) \approx (X - X_{-1})/X_{-1}$ (approximately the growth rate)

APPI	Agriculture Product Price Index
CGPI	Corporate Goods Price Index
COEPI	Coal, Oil & Electricity Price Index
CPI	Consumer Price Index
DR	Deficit Ratio, $DR = \text{Deficit}/GDP$
ED	Nominal Excess Demand (Definition see page 28)
EDNP	Nominal Excess Demand Net Potential Real Growth (Definition see page 28)
Fis	Fiscal Policy Instrument (Deficit Ratio as proxy)
FP	Factor Price Index
GAP	$GAP = LRY - LRYHP$
I _{dep}	Annual Deposit Rate
I _{lend}	Annual Lending Rate
LM2GAP	Excess Money Growth
LRY	$LRY = \log(RY)$
LRYHP	$LRYHP = \text{smooth_hp}(LRY, 6.25, LRYHP)$
M1	Currency in circulation
M2	$M2 = M1 + \text{Savings}$
MPPI	Mining Product Price Index
NEER	Nominal Effective Exchange Rate
NW	Nominal Wage for an Average Employee
NY	Nominal Gross Domestic Product (current price)
Pi	Rate of Inflation
PPPI	Processed Products Price Index
REER	Real Effective Exchange Rate
RPI	Retail Price Index
RW	Real Wage
RY	Real Gross Domestic Product Index (1977=100)
WOP	World Oil Price